A THEORY OF COMPUTER BASED MANAGEMENT CONTROL

By

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by

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This study deals with a man-machine system and the application of the computer in top management financial decision making. An attempt is made to determine the theoretical basis for a man-machine interactive computer system in financial management planning and control and examine the process of computer based decision making in top management financial planning and control.

The basis of this study is the interaction between the financial manager of the business firm and a computer based decision making system subject to the objectives of determining the criteria for such a man-machine relationship. It is shown that heuristic interaction between man and the computer subject to goal orientation is a feasible technique for achieving a desired company objective.

A formalized man-machine system is defined which serves as the theoretical foundation for the implementation of the top management man-machine interactive decision making system. This study then demonstrates

the feasibility of such a man-machine management control system in the form of the "Financial Interactive Planning Simulator," a top management financial decision making simulation system which has been implemented on a time sharing computer system and operates in the complementary mode. This simulator demonstrates that the computer can effectively complement the decision maker and, in turn, the decision maker can objectively complement the capabilities of the computer.

The financial planning and control system is based on a deterministic model of the corporate financial structure and allows the user to assess expected consequences of changes in controllable variables while optimizing a chosen objective function over a given planning period. The user interacts with the system in the conversational mode via a time sharing terminal by making decisions which are tested by the system against criteria specified in a dynamic financial performance matrix. The system analyzes the sensitivity of a user-supplied financial decision recommendation and supplies the user with feasible alternatives for improving the tentative decision relative to optimizing the objective function. The user then has the option to modify his recommendation and/or to accept changes in the financial performance matrix. The system leaves all decision making to the user and functions primarily as a decision analyzer and performance measuring device in the financial planning and control process.

CHAPTER I

INTRODUCTION

The Nature of the Problem

The purpose of this study is to apply the capabilities of computer technology to the area of top management financial decision making and determine the theoretical basis for a man-machine interactive computer system in financial management planning and control. The theoretical basis will then be extended to a computer time sharing system which is to demonstrate the feasibility of this man-machine relationship in the management decision making process.

Computer Technology and the Financial Management Process

The computer is in the eyes of many a helpful tool for performing routine tasks more efficiently than man can. In short, the electronic computer is a labor saving device. Is that the limitation of the computer? The answer was quite appropriately 'yes' a decade ago. However, the functions of the computer today entail the performance of tasks which will have an even greater impact than its so-far-proven ability to do very rapid calculations and to store and recall large volumes of data.

John Diebold (1959) characterized this new capability by pointing out that the utilization of the computer is a way of "thinking as much as it is a way of doing...." It is no longer necessary to think in terms of individual machines, or even in terms of groups of machines; instead, for the first time, it is practical to look at an entire production or

information handling process as an integrated system and not as a series of individual steps."

Information processing has a long history dating from the origin of mankind. Electronic information processing, on the other hand, has been available for such a short time that its implications are still not widely understood.

Computer technology has changed very rapidly. The first electronic computer, built in the 1940's, is already history. Techniques of computer uses, pioneered in the late 1950's, are today obsolete. Why? Have science and technology advanced so rapidly and thus given the computer and the methods for its use these phenomenal growth characteristics? Or should one argue that the outstanding potentials of the computer and the multitude of applications that can be left to its powerful capabilities are only slowly accepted? There is no doubt about the validity of the first argument (Armer, 1966). Computer speeds alone will attest to this technological advance. In addition to the rapid increase in speed, the computer has acquired many other capabilities. Besides continuing to serve as a rapid calculator, electronic data processing systems of today serve as central control points for communication networks by carrying out the functions of network switching, data acquisition from and data dissemination to distant locations. Computers serve as central depositories for large volumes of data, and manipulate these data for the purpose of gaining useful information.

To grasp the underlying principles of such capabilities and to understand the associated techniques is no easy task. Here lies, perhaps,

the reason for the slow acceptance of data processing. This lagging acceptance becomes particularly significant when one realizes the ever-increasing involvement of computers in daily living -- whether it be a college student pursuing his educational goal, a scientist attempting to find the answer to an unsolved problem, or a businessman searching for more effective techniques for decision making.

This prerequisite for successful business management, for example, in today's complex environment in no way implies that the manager's decision will always result in the use of the computer for the solution of his managerial and operational problems. It does imply that a good business decision requires the analysis of realistic alternatives which include among many such alternatives the utilization of computers. That computers are being utilized to an ever increasing degree is demonstrated by the following statistics (AFIPS, 1966). The total number of digital computers installed in 1950 was approximately fifteen. In 1965 this figure had risen to thirty thousand. During the five-year period beginning in 1965, this number is expected to double. Looking at this growth pattern in terms of dollars invested, there is again detected a phenomenal growth rate. From an investment of .03 billion dollars in 1950, data processing growth has resulted in investments totaling 7.8 billion dollars in 1965. By 1970 this figure is expected to increase more than 100 per cent to 18 billion dollars.

This significant growth in the use of computers has been spurred by the complexities of today's management decision process. Management control of the business firm is dependent on a control system which

comprises six distinct elements:

1. the manager who must ultimately decide which action to take, and when;
2. the management information systems which provide the manager with the data on which he bases his decisions;
3. models depicting various organizational aspects of the firm which allow the manager to test alternate courses of action;
4. a feedback control system;
5. the computer; and
6. computer application technologists who incorporate the computer into the management control system.

It should be emphasized again at this point that the subject of this study is the top level manager and his corporate financial decision making functions. In his capacity as a financial manager the management decision maker faces two objectives:

1. he must be sure that sufficient funds are available to maintain current operations; and
2. he must work toward the maximization of long-run profits of the firm.

In view of these objectives, corporate financial management can be divided into four distinct but interrelated decision processes:

1. the operating control decisions:
   it is imperative that the firm's operations are effectively controlled;
2. the investment decisions:

capital must be allocated to investment proposals the benefits of which are realized at some future date;

3. financing decisions:
   decisions must be made regarding the source of capital for investment purposes, and, in particular, a choice must be made between long-term debt and common stock issuance;
4. the dividend decisions:
   decisions must be made on the level of earnings paid out to stockholders.

The decision maker is thus faced with the problems of:

1. detecting and correcting weaknesses in the firm's financial structure and operating levels; and
2. recognizing financial strengths and applying them to increased operating performance and to improving the financial strength of the corporate structure.

Prior Research

The nature of management, and in particular the nature of financial management, is closely related to and can be identified as a collection of problem solving efforts. The process of problem solving has long been a particularly interesting challenge to researchers and has gained added impetus with the advent of the electronic digital computer. Opportunities presented themselves now which allowed for the formulation of problems in the form of models and to represent such models as computer programs. One of the earlier and outstanding efforts is represented by the develop-

ment of the General Problem Solving program (GPS). In a paper given at the International Conference on Information Processing (Newell, Shaw and Simon, 1959) it was demonstrated that human behavior can be simulated by means of a computer program. In particular, the model was designed for the purpose of solving symbolic logic problems by causing the General Problem Solving program to simulate the human behavior demonstrated when solving such a problem in symbolic logic. It was recognized by the researchers that each person behaves to some degree differently. However, it was found in tests that the majority of persons utilized a common set of basic processes involving the use of means-ends type of analyses. Hence, the authors have attempted to incorporate the strategies of means-ends analysis into the problem solving strategies of the computer program. An additional attempt was made to incorporate a second problem solving technique into the computer model, namely, that of abstracting a complex problem into a simpler one. Upon solving the simpler problem, information learned from this problem execution is then applied to the solution of the original complex problem. Newell, Shaw and Simon report significant success in utilizing the General Problem Solving program to solve symbolic logic problems and trigonometric identities. However, the General Problem Solving program has not been employed in more general problem solving environments such as financial management. Newell and his associates conclude that the behavior of a human can be understood as a product of a complex but finite and determinate set of laws. However, the technique utilized for representing this behavior in a computer program does not provide a general framework for understanding problem solving behavior

and does not render itself useful in applications other than very specific problems.

Other efforts in the area of simulating human behavior come closer to the area of management decision making and, in particular, to the area of financial decision making. A very significant effort is that of Clarkson (1962) who developed a computer model which simulates the technical behavior of a trust officer who must make decisions in the trust investment process. Clarkson recognizes the abundance of information which must be evaluated prior to making an investment decision. These investment decisions are subject to constraints and include legal restrictions as well as the specific desires of the client. The model presented is simulating the investment problem under uncertainty. In developing the model, Clarkson relies upon the theory developed by Newell, Shaw and Simon in the General Problem Solving program. The decision processes simulated are used iteratively and recursively. The logic searches industries and companies for specific attributes, creates sublists which are in turn searched and again divided into sublists. Upon continued division of sublists, the search will finally identify the common stock which meets desired criteria. In order to identify the behavior of the trust officer, the model incorporates basic rules which resemble the characteristic behavior of the officer in making portfolio selections. These rules were obtained by interviewing trust officers and observing their behavior by reviewing past and future portfolio selection decisions. Hence, the value of the portfolio selection model relies greatly on the accuracy of the rules specified. These rules, in turn, can only be as accurate as the

accuracy of the decisions which were observed among the interviewed trust officers. This portfolio selection model represents a significant step toward the automation of the portfolio selection process. However, the decision rules implemented in the model restrict the total decision making process to these preconceived rules, the validity of which are difficult to test and verify.

A different approach to the portfolio selection process was taken by Markowitz (1959). He formulates a probability model which represents the overall portfolio, expected values and expected returns of the portfolio as well as measures of risks which are expressed as variances. The input to his model are probability beliefs, expected values as well as variances and co-variances for each individual security to be analyzed. The second part of his portfolio selection process is represented by an optimization model which utilizes parametric quadratic programming to determine an optimum portfolio subject to given constraints. The output from the portfolio selection process is a portfolio with a maximum expected value for the return which represents a minimum variance and also satisfies all constraints. Markowitz bases his portfolio selection model on the assumptions that there exists an uncertainty of returns from any given investment and that there exists a correlation among security returns. He argues that risks can be reduced by avoiding portfolios whose securities are all highly correlated. His optimization strategy then follows the security investment objectives that high returns are desired at low risks but, other things being equal, certainty is preferred over uncertainty. The process of portfolio selection consists of three steps:

1. Probabilistic estimates are made of future performances of securities.
2. The probabilistic estimates are analyzed to determine the efficient set of portfolios.
3. From this efficient set a portfolio is selected which best suits the investor's preferences.

A portfolio is considered to be efficient if it is not possible to obtain higher expected returns with no greater variability of return, or obtain greater certainty of return with no less average return. The portfolio selection model proposed by Markowitz is based on statistical measures which are assumed by him to represent risk realistically. The user of the model must accept a statistical framework which determines functional relationships, defines risks and their respective levels for given securities and hence does not permit the introduction of risk factors which may affect a security but has not been made an element of the portfolio selection system.

Models which describe specific decision processes and relate to a single business problem are heavily challenged by research in the area of model building where the total firm is the basis of the model. In formulating total firm models, specific emphasis is placed on describing the functional relationships and interactions of the subsystems within a firm. This gives rise to an examination of the results of having elements of a business system interact with each other. Because of the complex nature of the business organization, the level of aggregation in describing the simulation model of the firm becomes a very significant

factor. Hence, research efforts have been directed toward constructing total firm simulation models which are subject to abstracting specific functions and placing emphasis on given subsystems at the expense of ignoring others. A model of a firm which simulates a hypothetical company, Task Manufacturing Corporation, consists of subsystems for functional areas which comprise the total firm and its environment (Sprowls and Asimow, 1960). Each subsystem describes the behavior of individual units within that system such as purchasing or shipping. Hence, the Task Manufacturing Corporation simulator consists of a collection of micromodels which represent the various functions of the firm. The simulation model has been described by Sprowls and Asimow as follows:

> In a sense, each model of a subsystem is analogous to a "black box" and if certain inputs are specified, outputs will appear. Some of the outputs are uniquely determined and some are determined only in a stochastic sense.
>
> Just as a collection of subsystems does not comprise a business firm, neither does a collection of models comprise a representation of a business firm. The subsystems must be coupled together to permit inputs and outputs to come from and exit to both the external world and other subsystems. Formal policies, managerial decisions, and informal policies which have developed from customs and traditions determine the ways in which these couplings are allowed to occur. The set of human and material subsystems and the couplings conditioned by formal and informal policies comprise the business firm. Correspondingly, the set of separately programmable models of subsystems coupled by interconnecting programs comprises a representation of a business firm--a simulation firm which can be manipulated on a computer.

The significance of this model lies in the flexibility offered because each subsystem is independent of all other subsystems and therefore allows the user to concentrate on simulating a specific subsystem without being

forced to place equal emphasis on the rest of the system. In addition, model outputs can be determined non-stochastically whereas other outputs are determined stochastically.

Another simulation of a manufacturing firm is a model proposed by Bonini (1963). His model is also a functional model similar to that proposed by Sprowls and Asminow. However, Bonini places emphasis on the information and decision system within the firm. A unique element of his model is the representation of behavioral factors in the model. These factors are given in the form of indices of pressure on individuals within the firm which affect their performance and decisions. For example, the index is used as the basis for determining the mean and standard deviation of the sales distribution which determines the salesman's monthly sales rate. The control subsystem in the model is in the form of sales quotas and manufacturing standard costs in addition to the indices of pressure on individuals. The indices of pressure thus become an indirect control on the firm's operations. These felt pressures have an effect on the level of the manufacturing processes, administrative expenses and the performance of the sales staff. The effect is measured by changes in the means and standard deviations of distributions from which the values for given simulation periods are chosen.

A pioneering effort in building a general model of the business enterprise which gives the top management decision maker a tool for simulating the operations of the business firm is the Top Management Decision Simulation which was developed by the American Management Association (Ricciardi, 1957). In this simulation model, all major functions

of the enterprise are incorporated and no aggregations of specific functional areas are considered. The Top Management Decision Simulation was implemented on the computer in the form of a business game. The game is designed for team play and is executed in an interactive and competitive environment. Hence, a key element of the model is the exploitation of the competitive nature of business operations. The game defines more than one firm and each firm receives information about its own operations, information about the industry and the specific market in which it is operating. An essential element of such a business game is the quantitative description of the market and the determination of economic indices. This environment, in conjunction with algorithmic procedures defines the constraint system of the model and outcomes of the simulation are influenced by the input decisions of the user of the game as well as the predetermined and nonvariable structure of the market and market forecasting process. The market mechanism, perhaps, is the weakest link in the model because, despite an appearance of realistic behavior, no claims have been made that such market mechanisms do indeed exist in reality.

A great number of general management games followed after the initial success of the Top Management Decision Simulation developed by the American Management Association. A noteworthy example is the IBM Management Decision Making Laboratory (IBM Corporation, 1963).

Simulation models which include the user as an integral part of the simulation process have had significant attention and much research has been conducted in this area. Because of the insufficiently high level of computer technology and/or the high cost of implementing and operating

such a man-machine model, research efforts have been less significant in this area. However, the RAND Corporation has made a significant contribution in the form of the Logistics Systems Laboratory (Geisler, 1960). In the laboratory, both the computer and the manager are active participants in the simulation process and both are an integral part. The laboratory has been used to test various man-machine techniques. For example, one laboratory problem was to investigate two alternative management structures; one in which material management is assigned primarily to the weapons system manager and the other in which material management is assigned to the inventory manager. The objective of this laboratory problem was to examine the performance of logistics systems.

Mattessich (1964), referring to efforts to build simulation models, emphasized the need for research in a specific area:

> There cannot be any doubt that these endeavors will ultimately benefit business practice and will in the long run decisively influence the science of business administration and management, but there is a need -- and perhaps a more urgent one -- for an entirely different way of simulating the firm. One that is not directed toward "enterprise construction," but one that merely aims at improving the existing system of operating budgets. One that does not substitute more or less rigid decision rules for middle management by means that are set moderately enough to be immediately realizable. Realizable in a large number of enterprises, even those of middle and small size, where neither vast financial means nor electronic computers are at the disposal of the individual firm. The novelty of computer simulation as applied to the enterprise may easily deceive us that a budget simulation model is nothing but a paltry or diluted version of the management control models of the type just described. However, the goals, the range of expenses, the technical features, the expertness required, the range of application, and the effect on accounting, are entirely different ones in these two approaches.

The Corporate Financial System and the Needs for a Simulation Model

The complexity of the corporate financial management decision problem can be visualized from Figure 1.1 which identifies the flow of assets and costs through the corporate financial structure. Financial decision making relates to this corporate financial system in the form of the arrows. The decision maker determines the dollar amount of flow toward specific sections of the system. The interactions of balance sheet variables and income statement variables are controlled by operating decisions and are kept in balance via the profit/loss flow. Because of the multitude of sectional relationships within the closed system and the close interrelationships of the operating and financial position variables, the management decision and control process becomes very complex and cannot be carried out effectively without providing the manager with new capabilities. This new capability will hopefully be found in the computer and quantitative techniques which, in turn, take advantage of computer capabilities.

An area of research which utilizes the above described financial system as the basis and offers to bridge the gap left by prior research efforts should address itself to satisfying the following needs of a financial management simulation model:

1. The simulation process should be subject to exception reporting. This can be accomplished by specifying control limits upon variables, analyzing the system and then determining which variables exceed specified control limits.

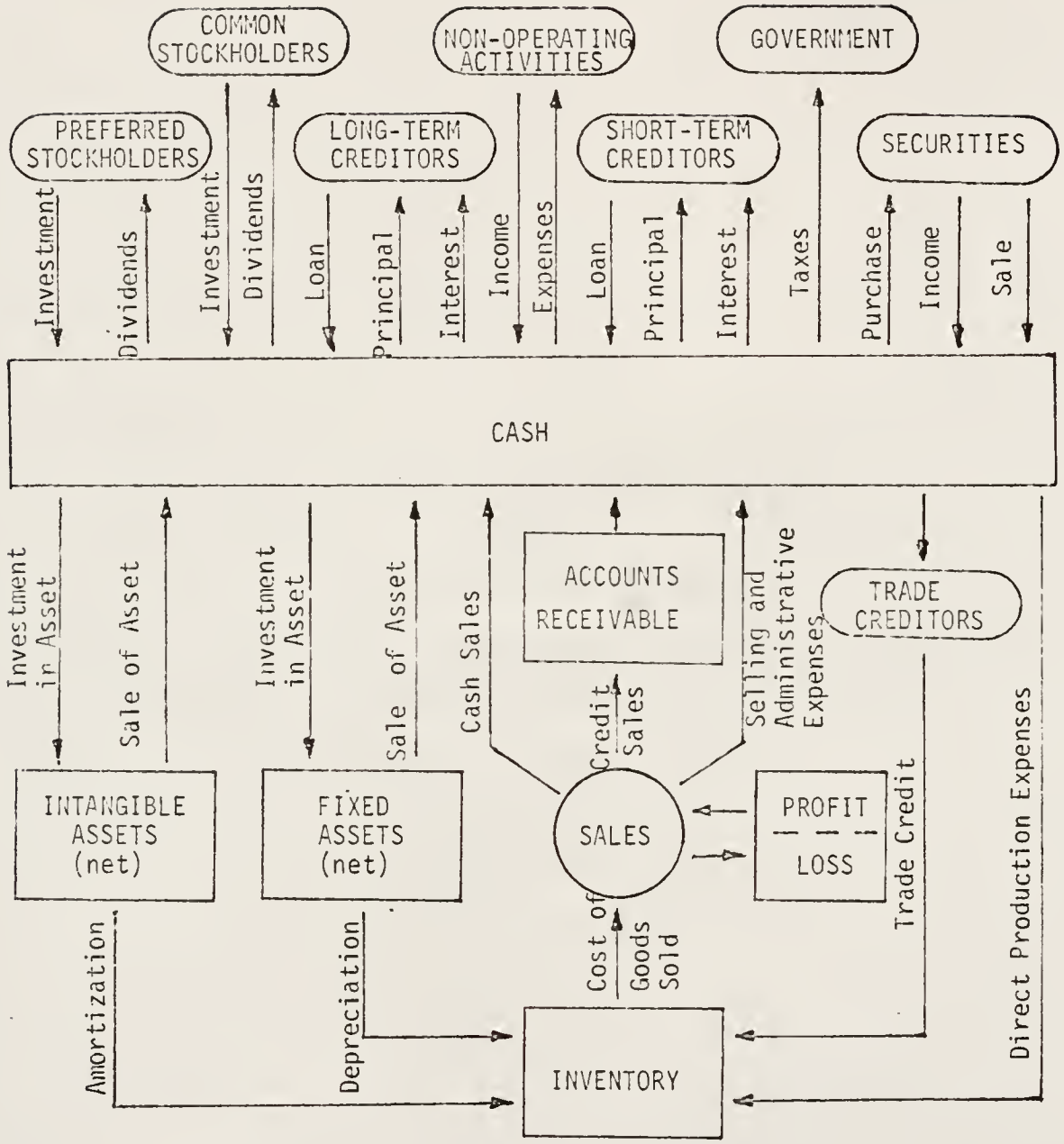

Fig. 1.1. The corporate financial system.

2. The simulation model should provide for online comparisons between model trials. The system should examine results, compare them with previous results, allow for the revision of assumptions and then repeat the simulation cycle.
3. A simulation system should have the flexibility which allows the user to assign values to all variables except those that are determined by functional relationships inherent in the model.
4. The system should have the flexibility to allow for the assignment of a new value to a variable when proceeding to the next planning period without being restricted by algorithmic procedures which keep the dynamic nature of the relationship of a variable in one period to the next planning period rigid.
5. A simulation model must have the user in mind, that is, the simulation model must be easy to use and should provide for flexibility in the manipulation of the model.
6. The model should avoid detailed subsystems which do not correspond with the management decision process at the corporate level.
7. The system should have interactive capability. This interactive capability should give the user the opportunity to revise decisions without delay.
8. The model should not produce the plan, rather, it should be in support and facilitate the planning process.
9. The model should be free of static decision rules.

Postulates and Hypothesis

Postulates Relating to Computer Technology

The trend toward the "computer utility" will affect management controls significantly (Business Week, 1968). Aside from supporting management through an efficient flow of information, the computer begins to take a more active role in the total management control process. According to Drattell (1966), companies set a significant percentage of their annual sales aside for computer expenditures. However, it should also be realized that the smaller company pays a much higher price for the use of computer service than the larger company. The significance of the computer expenditure decision warrants the assumption that most effective computer use comes from the control of this activity by top management.

Top management continues to take a more active role in data processing and is becoming more and more knowledgeable on data processing techniques. The increasing knowledge of top management continues to support the trend toward top management involvement in computer operations.

The most significant factor supporting the evolution of the "computer utility" lies in the user's selection criteria on the basis of computer performance (Hollander, 1967).

As pointed out by Finke (1965) before the U. S. Senate Subcommittee on Antitrust and Monopoly, the computer's economic impact can best be identified by the following three trends:

1. computer prices are decreasing;
2. computer performance is increasing; and

3. computer use is increasing at a rapid rate.

The impacts of the computer and automation have introduced many labor saving techniques which permit business organizations to cope with the ever increasing volume of data to be processed. The role of the computer is changing from that of a computational tool to becoming a part of the synthetic process of decision making. Hence, the assumption is made that computer technology permits the utilization of the computer as an amplifier of human intelligence and as an extension of human ability to think and create. The computer is therefore considered as a congruous element in the feedback control loop of management decision making.

The introduction of new concepts within business organizations presents problems because of the manager's unwillingness to readily adapt to change. These problems, it will be assumed, are overcome because the manager must realize that the complexities of present day communication systems within the organization jeopardize his effectiveness unless he adapts to technological change.

The application of computer technology in the management control process becomes even more significant with the introduction of data communication capabilities. The remote access to the computer, hence, stimulates more diverse utilization of computer capabilities. A significant assumption relates to the computer-problem interface, the common boundary between the computer and the problem which is in the form of a computer program. It will be assumed that this interface problem can be overcome and result in the interdisciplinary overlap between the subject area specialists

and the computer technology specialists. Hence, complex management processes can be translated into feasible computer procedures. In overcoming the computer-problem interface, it must also be postulated that the direct use of the computer by the decision maker is feasible and allows the decision maker to interact with the computer without the aid of a computer technology specialist. This assumption is necessary if the decision maker is to support his thinking process via a direct and immediate access to computing power to manipulate decision variables and respond to system feedback to obtain immediate information.

Postulates Relating to the Financial Management Simulator

The proposed financial management simulator is based on the structure of the corporate financial system (Fig. 1.1). The capabilities of the simulator are based on the assumption that financial management and long-range financial planning consist of a combination of judgment and analysis. Therefore, the model structure does not consist of a set of rules governing actions to be taken as a consequence of input. On the contrary, it is assumed that the simulator can be an effective management tool if the decision maker himself becomes an integral part of the management control simulation process. It will therefore be assumed that the computer model can function effectively if, instead of rules governing actions to be taken, the simulator functions entirely on the basis of those algebraic relationships which define the corporate financial process.

It must then, however, be postulated that operating rules can be supplied by the decision maker himself and will result in the capability

of the computer system to give an effective response.

However, the feasibility of the application of operating rules supplied by the user of the simulator is assured if the assumption can be made that the effectiveness of the decision maker is not undermined by the complexity of the operating rule formulation process.

It is also assumed that the manager can improve his decision making capabilities by formulating a financial decision and receiving the results of his decision from the simulator subject to a system of financial constraints imposed on the organization.

The management simulator assumes that operating levels do not change from period to period unless the manager intervenes and changes a given operating level.

The financial management simulator is a top management planning and control tool. It is to aid in controlling the financial soundness of current operations and serve in the long-range financial planning process.

Hypothesis

On the basis of the identification of the combination of unsatisfied needs for a financial management simulator and the assumptions made, this study sets forth a hypothesis which, if proven valid, will offer the top management decision maker a feasible system for management planning and control in the form of a financial management simulator. The hypothesis is as follows:

Given today's technology and accounting conventions, it is possible to design a computer based financial simulation model based upon the balance sheet, the income statement and the financial ratios inherent therein. Such a model, being deterministic and without forecasting algorithms, can be made to respond directly to the decision maker's interrogation in order to assist the decision making process.

Scope and Methodology

The exploration of the feasibility of the application of computers to extend the top manager's decision making capabilities requires a thorough understanding of the dynamics of computer technology and the impact of that technology on the manager's decision making environment. This study deals with the question of whether the computer can be used to assume management functions and/or extend the management decision process. An investigation is made of the feasibility of using the computer to support the management decision making process in a real time environment. In conjunction with this investigation, it is necessary to determine the feasibility of man-machine systems in the management decision making process.

The proposed financial planning and control simulator is based on the deterministic model of the corporate financial structure and allows the user to assess expected consequences of changes in controllable variables while optimizing a chosen objective function over a given planning period. The user of the simulator interacts with the system in the conversational mode via a time sharing terminal by making decisions

which are tested by the system against criteria specified in a dynamic financial performance matrix. The system analyzes the sensitivity of a user-supplied financial decision recommendation and provides the user with feasible financial recommendations which enable him to test feasible alternatives for improving the tentative decisions relative to optimizing the objective function. The user then has the option to modify his recommendation and/or to accept changes in the financial performance matrix. The system leaves all decision making to the user and functions primarily as a decision analyzer and performance measuring device in the financial planning and control process.

The decision which becomes input to the system may be the output from a stochastic subsystem and, hence, may have been arrived at by considering risk.

The model to be formulated does not consider the constraints of such subsystems, but accepts a given decision as "the best we can do for the moment." However, the model permits the decision maker to vary his input decision and thus offers him the opportunity to measure the rewards of risk taking in the form of profit determined by the system subject to the exogenous risk levels controlled by him. Hence, decisions may result from probabilistic models, but, when entered into the financial management simulator, all decisions become deterministic.

In particular, it is shown how the systems analysis approach, based upon closed loop feedback systems which interrelate company activities in financial terms, can result in an effective management simulation process.

The top manager is able to utilize the simulator by selecting a set of performance measures which are consistent with company objectives and ask "what if" questions pertaining to the testing of the operational strength of the firm and the capabilities for reaching a given long-range objective.

Relatively little has been accomplished in designing effective computer based planning and control systems because of the emphasis toward the design of models which attempt to base the entire simulation on algorithmic procedures and thereby excludes the judgmental capabilities of the decision maker from the simulation process. This management simulator forces both the manager and the computer to complement each other and thus makes the decision maker an integral part of the computer based system. This financial management simulator is subject to the decision criteria of the top manager and responds to the decisions of the user, performs sensitivity analyses on the basis of the user-supplied decisions and guides the manager in analyzing and evaluating his decision. The computer system is based on exception reporting, that is, control limits are entered into the system, an analysis is performed by the system and, in turn, the system informs the management decision maker when simulated values exceed the control limits. Furthermore, the system attempts to aid the management decision maker by providing the capability of making comparisons between the current decision and previous decisions.

In designing the computer based system, efforts are made to avoid abstract formulation of functional relationships or decision processes. Instead, the manager is required to make objective decisions. Hence,

because of the assignment of decision making functions to the user of the system, results of the simulation process are more representative of real situations rather than decision outcomes based on abstract relationships. In addition, the computer system is designed with the user in mind. In other words, the user is not hindered in his decision making process by complexities of the system itself. Rather, the financial management system is easy to use and offers quick and easy-to-interpret conclusions derived from the input decision.

Within the scope of this study, an attempt is first made to formulate the structure of financial activities in mathematical form. In Chapter II the structure of financial activities within the business organization are identified. Then, in turn, these definitions serve as the basis for designing the man-machine simulation model which is the vehicle for demonstrating the validity of the hypothesis. Upon defining the income statement, the balance sheet and other financial operating activities, a system of mathematical equations is formulated which expresses all financial activities that become elements of the simulation model. This mathematical formulation is then extended to the planning horizon for the purpose of demonstrating the functional relationships which exist between financial activities in various planning periods.

In Chapter III a formulation of an objective function is offered which will serve as a measure of accomplishment in the operation of the financial simulator. In this chapter there is also developed the feed-back control mechanism for the simulation process. The feed-back control is in the form of financial ratio standards with upper and lower bounds.

This constraint system consisting of financial ratios forms the basis for sensitivity analyses which are to aid the user of the management control system in making his decisions. The financial ratios are chosen for this purpose because of the interdependent nature of the financial system and the difficulty inherent in a financial system for measuring the activity levels and controlling levels of performance.

In concluding the mathematical formulation of the financial system to be incorporated in the simulation model, the financial system is formalized and financial activities are combined through the formulation of the objective function and constraint system which results in the mathematical representation of the management control system simulator. The combined mathematical system, hence, consists of an objective function, definitional equations for financial activities and the constraint equations which represent upper and lower bounds on financial ratio standards.

Based on the mathematical formulation of the simulation system, Chapter IV is devoted to the design of the computer based system. The computer program to be implemented is designed in order to demonstrate the validity of the hypothesis underlying this study. First, the general system flow is developed. This general system logic forms the basis for the man-machine interactive model and has an overriding influence on the design of the input and output elements of the computer system. The study then proceeds to a detailed analysis of the input and output requirements for the system. Upon defining the computer system and the specifications of input and output requirements, the detailed system logic is developed. The program logic of the management planning and control

simulator is based on the interaction of man and machine during the simulation process.

The computer based simulation system is then utilized to demonstrate how the manager uses the system in the management decision making process. This application also serves as a demonstration of the validity of the hypothesis and to verify the feasibility of man-machine interactive financial decision making.

Expected Results

The computer as a tool of the decision maker can serve a significant function by participating in the management process in a time sharing role and by assisting the manager in controlling the information formation process in the company's operation. Furthermore, the computer can assist the manager in organizing and controlling the multitude of management decision variables. These efforts are not solely aimed at benefiting the large organization and are not specifically aimed at assisting in the analysis of the most complex type of problem a business manager can face. The computer can only become a useful tool if it is capable of being programmed for a wide range of problem applications.

The user of computers and the computer itself reach the maturity which enables both to work as a harmonious team to meet these challenges if the technical aspects of computer technology can be effectively implemented.

The reader is therefore encouraged to view the technical aspects of information processing on a comprehensive basis which results in a clearer understanding of present capabilities and future potentials.

Despite the availability of the previously mentioned benefits of increasing computer technology, one problem which has not been solved yet very successfully is that of the "faith and understanding gap" (Withington, 1966). The technical nature of computer use and the need for highly trained subject area specialists make it difficult to find a person who is well versed in both areas. The resultant void in the computer-problem interface has caused many problems in the past and will continue to do so for some time to come.

This study sets out to serve these purposes with the premise that the next stage of data processing will be centered around the "computer utility." It will be shown that past and current methods are necessary prerequisites and foster the evolutionary shaping of information processing capabilities and requirements. A financial management simulator is presented as a demonstration of the feasibility of a computer based man-machine interactive decision making system. This system serves to verify the validity of the hypothesis offered and verifies the theory of computer based management decision making.

CHAPTER II

THE STRUCTURE OF FINANCIAL ACTIVITIES

This chapter serves to identify the structure of financial activities. These definitions will serve as the basis for the design of the man-machine model to be discussed in Chapter IV. The set of financial activities does not represent a complete set because such undertaking would cause the computer model to be described later to be unnecessarily complex and cumbersome for the purpose of the study. Completeness was therefore sacrificed in order to assure consistency in the definition of the financial activity system. Some equations, however, may have to be changed by the user to reflect his situation. Consistency in the description of the functional relationships of financial variables is an essential prerequisite for the design and implementation of the management control simulator. This consistency has been maintained. In addition to avoiding complexity, an effort is made to eliminate the need for formulating deterministic financial relationships which require that assumptions be made which are not definitional in nature.

Definitions

For the purpose of offering a mathematical description of the system, nine variables must be defined. In the definition of these variables, dots indicate that when they are replaced by numeric digits, such

variables take on a unique definition within the general definition of that particular variable. To identify a time dependent variable the notation will indicate such time dependence of a variable by specifying the time period as a subscript following the variable.

The definitions of the variables are as follows:

$x1..._t$	Income statement variable for period t
$x2..._t$	Balance sheet variable at the end of period t
$x3..._t$	Other operating variable for period t
d.	Exogenous decision variable
t	Time period (t = 1, ..., T)
T	Planning horizon
r.	Financial ratio
b.	Financial ratio standard
$s..._t$	Slack variable

The income statement consists of sixteen variables the definitions of which are given in the formulation of the income statement displayed in Figure 2.1. The balance sheet consists of twenty-two unique variables. The balance sheet structure and the associated variables are defined in Figure 2.2.

In addition to income statement and balance sheet variables, other variables must be defined in order to formulate the financial system. These financial activities will be defined by variables which are classified as "other variables." Their definitions are as follows:

$x101_t$		Sales
$x102_t$	minus:	Cost of Goods Sold
$x103_t$	minus:	Selling and Administrative Expense
$x104_t$	minus:	Depreciation
$x104a_t$	minus:	Amortization
$x105_t$	equals:	Net Operating Income
$x106_t$	plus:	Nonoperating Income
$x107_t$	minus:	Nonoperating Expense
$x108_t$	minus:	Interest on Loans
$x109_t$	equals:	Net Income Before Taxes
$x110_t$	minus:	Federal and State Income Taxes
$x111_t$	equals:	Net Income
$x112_t$	minus:	Dividends on Preferred Stock
$x113_t$	equals:	Net Income on Common Stock Equity
$x114_t$	minus:	Dividends on Common Stock
$x115_t$	equals:	Net Income Transferred to Retained Earnings

Fig. 2.1. The income statement.

ASSETS

$x201_t$	Cash and Equivalents
$x202_t$	Accounts Receivable
$x203_t$	Inventories
$x204_t$	Current Assets
$x205_t$	Securities
$x206_t$	Gross Plant
$x207_t$	Depreciation
$x208_t$	Net Plant
$x209a_t$	Gross Intangible Assets
$x209b_t$	Amortization
$x209_t$	Net Intangible Assets
$x210_t$	Total Assets

LIABILITIES AND NET WORTH

$x211_t$	Loans Payable
$x212_t$	Accounts Payable
$x213_t$	Taxes Payable
$x214_t$	Current Liabilities
$x215_t$	Long Term Debt Unsubordinated
$x216_t$	Long Term Debt Subordinated
$x217_t$	Preferred Stock
$x218_t$	Common Stock
$x219_t$	Paid in Surplus
$x220_t$	Retained Earnings
$x210_t$	Total Liabilities and Net Worth

Fig. 2.2. The balance sheet.

$x301_t$ Cash Payment on Accounts Payable

$x302_t$ Cash Receipt on Accounts Receivable

$x303_t$ Purchase (or Sale) of Securities

$x304_t$ Purchase (or Sale) of Fixed Assets

$x305_t$ Interest Earned on Securities

$x306_t$ Nonoperating Income other than Interest Earned

$x307_t$ Cash Payment on Taxes Payable

$x308_t$ Short-term Loan Payment on Principal (or Receipt of Loan)

$x309_t$ Long-term Debt Unsubordinated Payment on Principal (or Receipt of Loan)

$x310_t$ Long-term Debt Subordinated Payment on Principal (or Receipt of Loan)

$x311_t$ Acquisition (or Sale) of Intangible Assets

$x312_t$ Number of Additional Shares of Preferred Stock Issued

$x313_t$ Price per Share of Preferred Stock

$x314_t$ Number of Additional Shares of Common Stock Issued

$x315_t$ Price per Share of Common Stock

$x316_t$ Production Cost on Trade Credit

$x317_t$ Other Production Expenses

The variables so far defined represent activities which are determined by the activities of the financial system. A complete mathematical description of the financial structure of the business organization also requires the definition of variables which are not controlled by the financial system and are therefore exogenous in nature. The following exogenous decision variables will be employed in the system:

d1	Rate of Interest Earned on Securities Held
d2	Rate of Depreciation
d3	Scale Factor for Dollar Amounts
d4	Rate of Amortization
d5	Rate of Interest on Loans
d6	Rate of Interest on Long-Term Debt Unsubordinated
d7	Rate of Interest on Long-Term Debt Subordinated
d8	Rate of Payment on Accounts Payable
d9	Rate of Receipt on Accounts Receivable
d10	Rate of Payment on Taxes Payable
d11	Par Value of Common Stock
d12	Number of Shares of Common Stock Outstanding at the end of period t = 0
d13	Number of Shares of Preferred Stock Outstanding at the end of period t = 0
d14	Base Year
d15	Current Year
d16	Rate of Capitalization for Objective Function

On the basis of the definitions of income statement and balance sheet variables, the following two systems of balancing equations represent income statement and balance sheet activities.

INCOME STATEMENT EQUATIONS

$$x101_t - x102_t - x103_t - x104_t - x104\,a_t - x105_t = 0$$

$$x105_t + x106_t - x107_t - x108_t - x109_t = 0$$

$$x109_t - x110_t - x111_t = 0$$

$$x111_t - x112_t - x113_t = 0$$

$$x113_t - x114_t - x115_t = 0$$

BALANCE SHEET EQUATIONS

$$x201_t + x202_t + x203_t - x204_t = 0$$

$$x204_t + x205_t + x208_t + x209_t - x210_t = 0$$

$$x206_t - x207_t - x208_t = 0$$

$$x209a_t - x209b_t - x209_t = 0$$

$$x211_t + x212_t + x213_t - x214_t = 0$$

$$x214_t + x215_t + x216_t + x217_t + x218_t + x219_t + x220_t - x210_t = 0$$

Operating Equations

The balance sheet, income statement and other activities are combined to form the following system of equations.

1. $x104_t = d2(x208_{t-1} + .5x304_t)$

2. $x104a_t = d4(x209_{t-1} + .5x311_t)$

3. $x105_t = x101_t - x102_t - x103_t - x104_t - x104a_t$

4. $x305_t = d1(x205_{t-1} + .5x303_t)$

5. $x106_t = x305_t + x306_t$

6. $x211_t = x211_{t-1} - x308_t$

7. $x215_t = x215_{t-1} - x309_t$

8. $x216_t = x216_{t-1} - x310_t$

9. $x108_t = d5(x211_{t-1} - .5x308_t) + d6(x215_{t-1} - .5x309_t) + d7(x216_{t-1} - .5x310_t)$

10. $x109_t = x105_t + x106_t - x107_t - x108_t$

11. $x110_t = 0$ if $x109_t \leq 0$

$= .22x109_t$ if $0 < x109_t \leq 25{,}000$

$= .48(x109_t - 25{,}000) + 5{,}500$ if $x109_t > 25{,}000$

12. $x111_t = x109_t - x110_t$

13. $x113_t = x111_t - x112_t$

14. $x115_t = x113_t - x114_t$

15. $x302_t = x202_{t-1} + d9x101_t$

16. $x202_t = x202_{t-1} + x101_t - x302_t$

17. $x203_t = x203_{t-1} - x102_t + x316_t + x317_t$

18. $x205_t = x205_{t-1} + x303_t$

19. $x207_t = x207_{t-1} + x104_t$

20. $x301_t = x212_{t-1} + d8x316_t$

21. $x212_t = x212_{t-1} - x301_t + x316_t$

22. $x307_t = x213_{t-1} + d10x110_t$

23. $x213_t = x213_{t-1} + x110_t - x307_t$

24. $x201_t = x201_{t-1} - x103_t + x106_t - x107_t - x108_t - x112_t - x114_t$
$- x301_t + x302_t - x303_t - x307_t - x308_t - x309_t$
$- x310_t - x304_t - x311_t + x312_t x313_t + x314_t x315_t$
$- x317_t$

25. $x209b_t = x209b_{t-1} + x104a_t$

26. $x206_t = x206_{t-1} + x304_t$

27. $x209a_t = x209a_{t-1} + x311_t$

28. $x217_t = x217_{t-1} + x312_t x313_t$

29. $x218_t = x218_{t-1} + d11x314_t$

30. $x219_t = x219_{t-1} + x314_t x315_t - d11x314_t$

31. $x220_t = x220_{t-1} + x101_t - x102_t - x103_t - x104_t - x104a_t + x106_t - x107_t - x108_t - x110_t - x112_t - x114_t$

32. $x204_t = x201_t + x202_t + x203_t$

33. $x208_t = x206_t - x207_t$

34. $x209_t = x209a_t - x209b_t$

35. $x210_t = x204_t + x205_t + x208_t + x209_t$

36. $x214_t = x211_t + x212_t + x213_t$

37. $x210_t = x214_t + x215_t + x216_t + x217_t + x218_t + x219_t + x220_t$

The Operating System Extended Over the Planning Period

The financial activities formulated in previous sections must now be combined into a system which extends over the planning period T and therefore considers T time periods. In combining the T time periods into one system of equations, several simplifications in the mathematical formulation of the system are possible.

In general, consider an equation for T periods:

$y_t - y_{t-1} - w_t = 0$, for all $t = 1, \ldots, T$

The system of T equations is written as follows:

$y_1 - y_0 - w_1 = 0$

$y_2 - y_1 - w_2 = 0$

$y_3 - y_2 - w_3 = 0$

...

$y_{T-1} - y_{T-2} - w_{T-1} = 0$

$y_T - y_{T-1} - w_T = 0$

This system of T equations is recursively defined and can therefore be simplified into a single equation of the form:

$$y_T - y_0 - \sum_{t=1}^{T} w_t = 0.$$

Hence, the system of equations representing the operating activities extending over the planning period t = 1 through t = T can be written more compactly as follows:

1. $$x211_T - x211_0 + \sum_{t=1}^{T} x308_t = 0$$

2. $$x215_T - x215_0 + \sum_{t=1}^{T} x309_t = 0$$

3. $$x216_T - x216_0 = \sum_{t=1}^{T} x310_t = 0$$

4. $$\sum_{t=1}^{T} x302_t - \sum_{t=1}^{T} x202_{t-1} - \sum_{t=1}^{T} d9x101_t = 0$$

5. $$x202_T - x202_0 - \sum_{t=1}^{T} x101_t + \sum_{t=1}^{T} x302_t = 0$$

6. $$x203_T - x203_0 + \sum_{t=1}^{T} x102_t - \sum_{t=1}^{T} x316_t - \sum_{t=1}^{T} x317_t = 0$$

7. $$x205_T - x205_0 - \sum_{t=1}^{T} x303_t = 0$$

8. $$x207_T - x207_0 - \sum_{t=1}^{T} x104_t = 0$$

9. $$x212_T - x212_0 + \sum_{t=1}^{T} x301_t - \sum_{t=1}^{T} x316_t = 0$$

10. $$x213_T - x213_0 - \sum_{t=1}^{T} x110_t + \sum_{t=1}^{T} x307_t = 0$$

11. $$x201_T - x201_0 + \sum_{t=1}^{T} x103_t - \sum_{t=1}^{T} x106_t + \sum_{t=1}^{T} x107_t + \sum_{t=1}^{T} x108_t + \sum_{t=1}^{T} x112_t$$
$$+ \sum_{t=1}^{T} x114_t + \sum_{t=1}^{T} x301_t - \sum_{t=1}^{T} x302_t + \sum_{t=1}^{T} x303_t + \sum_{t=1}^{T} x307_t$$
$$+ \sum_{t=1}^{T} x308_t + \sum_{t=1}^{T} x309_t + \sum_{t=1}^{T} x310_t + \sum_{t=1}^{T} x304_t + \sum_{t=1}^{T} x311_t$$
$$- \sum_{t=1}^{T} x312_t x313_t - \sum_{t=1}^{T} x\ 314_t x315_t + \sum_{t=1}^{T} x317_t = 0$$

12. $$x209b_t - x209b_0 - \sum_{t=1}^{T} x104a_t = 0$$

13. $$x206_T - x206_0 - \sum_{t=1}^{T} x304_t = 0$$

14. $$x209a_T - x209a_0 - \sum_{t=1}^{T} x311_t = 0$$

15. $$x217_T - x217_0 - \sum_{t=1}^{T} x312_t x313_t = 0$$

16. $$x218_T - x218_0 - \sum_{t=1}^{T} d11x314_t = 0$$

17. $$x219_T - x219_0 - \sum_{t=1}^{T} x314_t x315_t + \sum_{t=1}^{T} d11x314_t = 0$$

18. $$x220_T - x220_0 - \sum_{t=1}^{T} x101_t + \sum_{t=1}^{T} x102_t + \sum_{t=1}^{T} x103_t + \sum_{t=1}^{T} x104_t + \sum_{t=1}^{T} x104a_t - \sum_{t=1}^{T} x106_t + \sum_{t=1}^{T} x107_t + \sum_{t=1}^{T} x108_t + \sum_{t=1}^{T} x110_t + \sum_{t=1}^{T} x112_t + \sum_{t=1}^{T} x114_t = 0$$

19. $x104_t = d2(x208_{t-1} + .5x304_t)$

20. $x104a_t = d4(x209_{t-1} + .5x304_t)$

21. $x105_t = x101_t - x102_t - x103_t - x104_t - x104a_t$

22. $x305_t = d1(x205_{t-1} + .5x303_t)$

23. $x106_t = x305_t + x306_t$

24. $x108_t = d5(x211_{t-1} - .5x308_t) + d6(x215_{t-1} - .5x309_t) + d7(x216_{t-1} - .5x310_t)$

25. $x109_t = x105_t + x106_t - x107_t - x108_t$

26. $x110_t = 0$ if $x109_t \leq 0$

$= .22x109_t$ if $0 < x109_t \leq 25{,}000$

$= .48(x109_t - 25{,}000) + 5{,}500$ if $x109_t > 25{,}000$

27. $x111_t = x109_t - x110_t$

28. $x113_t = x111_t - x112_t$

29. $x115_t = x113_t - x114_t$

30. $x301_t = x212_{t-1} + d8x316_t$

31. $x307_t = x213_{t-1} + d10x110_t$

32. $x204_t = x201_t + x202_t + x203_t$

33. $x208_t = x206_t - x207_t$

34. $x209_t = x209a_t - x209b_t$

35. $x210_t = x204_t + x205_t + x208_t + x209_t$

36. $x214_t = x211_t + x212_t + x213_t$

37. $x210_t = x214_t + x215_t + x216_t + x217_t + x218_t + x219_t + x220_t$

for all $t = 1, \ldots, T$.

The above system of thirty-seven equations can be simplified by substituting equations 19 through 31 into equations 1 through 18. The resultant system consists of twenty-four equations.

1. $x211_T + \sum_{t=1}^{T} x308_t = x211_0$

2. $x215_T + \sum_{t=1}^{T} x309_t = x215_0$

3. $x216_T + \sum_{t=1}^{T} x310_t = x216_0$

4. $\sum_{t=1}^{T} x302_t - \sum_{t=1}^{T} d9x101_t - \sum_{t=1}^{T} x202_t = x202_0$

5. $x202_T - \sum_{t=1}^{T} (x101_t - x302_t) = x202_0$

6. $x203_T + \sum_{t=1}^{T} (x102_t - x316_t - x317_t) = x203_0$

7. $x205_T - \sum_{t=1}^{T} x303_t = x205_0$

8. $x207_T - \sum_{t=1}^{T} x104_t = x207_0$

9. $x212_T + \sum_{t=1}^{T} (x301_t - x316_t) = x212_0$

10. $$x213_T - \sum_{t=1}^{T} (x110_t - x307_t) = x213_0$$

11. $$x201_T + \sum_{t=1}^{T} (x103_t - x106_t + x107_t + x108_t + x112_t + x114_t + x301_t - x302_t + x303_t + x307_t + x308_t + x309_t + x310_t + x304_t + x311_t - x312_t x313_t - x314_t x315_t + x317_t) = x201_0$$

12. $$x209b_T - \sum_{t=1}^{T} x104a_t = x209b_0$$

13. $$x206_T - \sum_{t=1}^{T} x304_t = x206_0$$

14. $$x209a_T - \sum_{t=1}^{T} x311_t = x209a_0$$

15. $$x217_T - \sum_{t=1}^{T} x312_t x313_t = 217_0$$

16. $$x218_T - \sum_{t=1}^{T} d11x314_t = x218_0$$

17. $$x219_T - \sum_{t=1}^{T} (x314_t 315_t - d11x314_t) = x219_0$$

18. $$x220_T - \sum_{t=1}^{T} (x101_t - x102_t - x103_t - x104_t - x104a_t + x106_t - x107_t - x108_t - x110_t - x112_t - x114_t) = x220_0$$

19. $$x204_t - x201_t - x202_t - x203_t = 0$$

20. $$x208_t - x206_t + x207_t = 0$$

21. $x209_t - x209a_t + x209b_t = 0$

22. $x210_t - x204_t - x205_t - x208_t - x209_t = 0$

23. $x214_t - x211_t - x212_t - x213_t = 0$

24. $x210_t - x214_t - x215_t - x216_t - x217_t - x218_t - x219_t - x220_t = 0$
for all $t = 1, \ldots, T$.

In an earlier section, a definition of the income statement and balance sheet activities was given mathematically in the form of balancing equations. When extended over the planning period T, the two balancing equations for each time period will extend into a system of 2T balancing equations as follows:

$$x101_t - x102_t - x103_t - x104_t - x104a_t + x106_t - x107_t - x108_t - x110_t - x112_t - x114_t - x115_t = 0, \text{ for all } t = 1, \ldots, T.$$

$$x201_t + x202_t + x203_t + x205_t + x206_t - x207_t + x209a_t - x209b_t - x211_t - x212_t - x213_t - x215_t - x216_t - x217_t - x218_t - x219_t - x220_t = 0, \text{ for all } t = 1, \ldots, T.$$

Note that $x220_t = x220_{t-1} + x115_t$, for all $t = 1, \ldots, T$.

Hence, the system of 2T balancing equations can be written as a single equation of the form

$$x220_T = x220_0 + \sum_{t=1}^{T} x115_t, \text{ or}$$

$$x220_T - \sum_{t=1}^{T} (x101_t - x102_t - x103_t - x104_t - x104a_t + x106_t - x107_t - x108_t - x110_t - x112_t - x114_t) = x220_0.$$

This equation, however, is the eighteenth equation of the activity system. Hence, the balancing equation is already represented and may, therefore, be disregarded.

CHAPTER III

THE OBJECTIVE FUNCTION AND THE CONSTRAINT SYSTEM

The Objective Function

The management control system to be formulated will not attempt to maximize an objective function from within the system. It will be assumed that the user of the system will control the maximization process by attempting to control the variables in such a manner as to maximize whatever goal the user of the system attempts to achieve. The objective function offered in this study will serve strictly as a measure of accomplishment and is therefore not an interdependent element of the mathematical formulation of the system. It must also be pointed out at this time that, though the system extends over the planning period T, system variables will not interact simultaneously over the T time periods. The simulation of the activities will be carried out sequentially by beginning the simulation process with period 1 and stepping it through the simulation, one time period at a time, until the specified planning horizon has been arrived at under manager control.

The specification of an objective function is in support of the simulation process and does not influence the simulation because of the choice of the variables to be included in the objective function. The objective function variables could easily be changed without affecting the mathematical formulation of the system or the logic of the simulation process.

For the purpose of this study, consider the following.

Maximize the sum of all net incomes on common stock equity for all planning periods t = 1, ..., T projected to the planning horizon T.

$$\text{Maximize } Z = (1 + g)^{T-1}\, x113_1 + (1 + g)^{T-2}\, x113_2 + \ldots + (1 + g)\, x113_{T-1} + x113_T.$$

or

$$\text{Maximize } Z = \sum_{t=1}^{T} (1 + g)^{T-t}\, x113_t,$$

where g represents the rate of return which determines the value of all net income streams at the planning horizon T. Hence, g is the rate of return which the manager requires as a minimum.

It should be noted that the maximum horizon value differs from the maximum present value only by a constant c as shown by the following identity:

$$(1 + g)^{T-t} = c\,\frac{1}{(1 + g)^t}, \text{ where } c = (1 + g)^T.$$

Let $c_t = (1 + g)^{T-t}$, for t = 1, ..., T.

Consider the following identity.

$$x113_t = x101_t - x102_t - x103_t - x104_t - x104a_t + x106_t - x107_t - x108_t - x110_t - x112_t.$$

But $$x220_t - x220_{t-1} = x115_t = x101_t - x102_t - x103_t - x104_t - x104a_t + x106_t - x107_t - x108_t - x110_t - x112_t - x114_t,$$

or $x220_t - x220_{t-1} = x113_t - x114_t$.

Hence, $x113_t = x220_t - x220_{t-1} + x114_t$.

The objective function can now be written as

$$\text{Maximize } Z = \sum_{t=1}^{T} c_t \, (x220_t - x220_{t-1} + x114_t).$$

Applying the distributive law this becomes

$$\text{Maximize } Z = \sum_{t=1}^{T} c_t \, (x220_t - x220_{t-1}) + \sum_{t=1}^{T} c_t \, x114_t.$$

Consider the function

$$F = \sum_{t=1}^{T} c_t \, (x220_t - x220_{t-1}).$$

Applying the distributive law again and expanding the summation results in

$$F = c_1 \, x220_1 + c_2 \, x220_2 + \ldots + c_{T-2} x220_{T-2} + c_{T-1} \, x220_{T-1} + c_T \, x220_T$$

$$- c_1 \, x220_0 - c_2 \, x220_1 - c_3 \, x220_2 - \ldots - c_{T-1} \, x220_{T-2} - c_T \, x220_{T-1}.$$

Upon collecting like terms, F can now be written as

$$F = - c_1 \, x220_0 + (c_1 - c_2) \, x220_1 + (c_2 - c_3) \, x220_2 + \ldots$$

$$+ (c_{T-1} - c_T) \, x220_{T-1} + c_T \, x220_T.$$

From the definition of c_t,

$$c_t - c_{t+1} = (1 + g)^{T-t} - (1 + g)^{T-t-1}$$

$$= (1 + g)^{T-t} [1 - (1 + g)^{-1}]$$

$$= (1 + g)^{T-t} [g (1 + g)^{-1}]$$

$$= g (1 + g)^{T-t-1}$$

$$c_t - c_{t+1} = g\, c_{t+1}.$$

Substituting in F above we obtain

$$F = -c_1 \, x220_0 + g\, c_2 \, x220_1 + g\, c_3 \, x220_2 + \ldots + g\, c_T \, x220_{T-1} + c_T \, x220_T.$$

Adding and subtracting the terms $c_{T+1} \times 220_T$ does not change the value of F.

$$F = -c_1 \, x220_0 + g\, c_2 \, x220_1 + g\, c_3 \, x220_2 + \ldots + g\, c_T \, x220_{T-1} + c_T \, x220_T - c_{T+1} \, x220_T + c_{T+1} \, x220_T.$$

Recall that $c_T - c_{T+1} = g\, c_{T+1}$.

Hence, F can be written as

$$F = -c_1 \, x220_0 + g \sum_{t=1}^{T} c_{t+1} \, x220_t + c_{T+1} \, x220_T.$$

Since $c_{t+1} = (1 + g)^{-1} c_t$,

$$F = -c_1 \, x220_0 + c_{T+1} \, x220_T + g (1 + g)^{-1} \sum_{t=1}^{T} c_t \, x220_t.$$

Since $c_1 = (1 + g)^{T-1}$ and $c_{T+1} = (1 + g)^{-1}$, F can be written as

$$F = -(1 + g)^{T-1} \, x220_0 + (1 + g)^{-1} x220_T + g (1 + g)^{-1} \sum_{t=1}^{T} c_t \, x220_t.$$

Or

$$F = -(1+g)^{T-1}\, x220_0 + (1+g)^{-1}\, x220_T + g\,(1+g)^{-1} c_T\, x220_T + g\,(1+g)^{-1} \sum_{t=1}^{T-1} c_t\, x220_t$$

$$= -(1+g)^{T-1}\, x220_0 + [(1+g)^{-1} + g\,(1+g)^{-1}]\, x220_T + g\,(1+g)^{-1} \sum_{t=1}^{T-1} c_t\, x220_t, \text{ since } c_T = 1$$

$$F = -(1+g)^{T-1}\, x220_0 + x220_T + g\,(1+g)^{-1} \sum_{t=1}^{T-1} c_t\, x220_t.$$

The objective function now takes on the form

$$\text{Maximize } Z = -(1+g)^{T-1} x220_0 + x220_T + g\,(1+g)^{-1} \sum_{t=1}^{T-1} c_t\, x220_t + \sum_{t=1}^{T} c_t\, x114_t.$$

Since $(1+g)^{T-1} \times 220_0$ is constant, the objective function can be written as Maximize Z = Maximize Z' - $(1+g)^{T-1}\, x220_0$ where

$$\text{Maximize } Z' = \sum_{t=1}^{T-1} [g\,(1+g)^{T-t-1}\, x220_t + (1+g)^{T-t} x114_t] + x220_T + x114_T, \quad T \geq 2.$$

The System of Financial Ratio Standards

The feedback control for the system will be in the form of financial ratio standards with upper and lower bounds. This system of constraints forms the basis for sensitivity analyses (see page 77) which aids the user of the system in making financial decisions.

Because of the interdependent nature of the financial system and the corresponding difficulty inherent in this system for measuring the activity levels and controlling the system's performance, a measuring device is necessary which permits a comparative analysis of all variables. The financial ratio was chosen for that purpose.

In particular, financial ratios will be utilized for the following specific purposes:

1. to permit the manager to set standards which become decision making criteria;
2. to be used as an analytical vehicle for sensitivity testing and the identification of those variables which require special attention of the manager because of their weakness in supporting desired activity levels; and
3. to test the standards themselves against each other to determine the sensitivity of the self-imposed standards relative to desired financial objectives.

It must be made clear that the financial ratios are not to be considered as standards which are solely used in a dichotomous fashion: they are met or they are not met. These ratios serve as catalysts in the sensitivity testing of the system and are solely an aid in identifying variables which require specific management attention. Therefore, the ratios must be subject to change as well as the financial data which are tested against the ratio standards. Hence, the manager must have the opportunity to change financial data or change the ratios themselves in order to maintain control over the feedback mechanism of the system.

The nature of the ratios becomes, therefore, strictly a function of the manager's objective and can be either industry or historical standards. The ratios are not an end in themselves. Instead, they are the vehicles which permit the testing of the sensitivity of variables in relationship to other variables. It is, therefore, desirable to identify as large a number of such relationships in terms of financial ratios as possible in order to meet the requirement for the identification of the system of ratios which represents the simultaneous system of interactions among all financial variables. The manager, however, retains control over each desired ratio by controlling its sensitivity to each standard. This is accomplished by changing the ratio standards until a particular ratio is forced into the set of sensitive ratios without loosing sight of the objective function. Hence, a given financial ratio may be made inoperative or may be forced to dominate all other ratios in the sensitivity analysis at the option of the manager. The constraint system will consist of twenty-eight financial ratios, the definitions of which, in addition to their bounds, are given below.

A. LIQUIDITY RATIOS: CRITERIA OF FINANCIAL SOUNDNESS

1. Current Ratio:

$$\frac{\text{Current Assets}}{\text{Current Liabilities}} \geq b1$$

$$\frac{x204}{x214} \geq b1$$

2. Quick Ratio:

$$\frac{\text{Current Assets - Inventory}}{\text{Current Liabilities}} \geq b2$$

$$\frac{x204 - x203}{x214} \geq b2$$

3. Inventory to Working Capital:

$$\frac{\text{Inventory}}{\text{Working Capital}} \leq b3$$

$$\frac{x203}{x204 - x214} \leq b3$$

4. Cash to Current Assets:

$$\frac{\text{Cash}}{\text{Current Assets}} \geq b4$$

$$\frac{x201}{x204} \geq b4$$

5. Cash to Total Assets:

$$\frac{\text{Cash}}{\text{Total Assets}} \geq b5$$

$$\frac{x201}{x210} \geq b5$$

6. Current Assets to Total Assets:

$$\frac{\text{Current Assets}}{\text{Total Assets}} \geq b6$$

$$\frac{x204}{x210} \geq b6$$

7. Gross Plant to Total Assets:

$$\frac{\text{Gross Plant}}{\text{Total Assets}} \leq b7$$

$$\frac{x206}{x210} \leq b7$$

8. Net Plant to Total Assets:

$$\frac{\text{Net Plant}}{\text{Total Assets}} \leq b8$$

$$\frac{x208}{x210} \leq b8$$

9. Current Liabilities to Total Assets:

$$\frac{\text{Current Liabilities}}{\text{Total Assets}} \leq b9$$

$$\frac{x214}{x210} \leq b9$$

B. LEVERAGE RATIOS: MANAGEMENT DECISION CRITERIA

10. Debt to Total Assets:

$$\frac{\text{Total Debt}}{\text{Total Assets}} \leq b10$$

$$\frac{x214 + x215 + x216}{x210} \leq b10$$

11. Times Interest Earned:

$$\frac{\text{Income before Interest and Taxes}}{\text{Interest Charges}} \geq b11$$

$$\frac{x105 + x106 - x107}{x108} \geq b11$$

12. Current Liabilities to Net Worth:

$$\frac{\text{Current Liabilities}}{\text{Net Worth}} \leq b12$$

$$\frac{x214}{x218 + x219 + x220} \leq b12$$

13. Fixed Assets to Net Worth:

$$\frac{\text{Fixed Assets}}{\text{Net Worth}} \leq b13$$

$$\frac{x208}{x218 + x219 + x220} \leq b13$$

14. Depreciation to Gross Plant:

$$\frac{\text{Depreciation}}{\text{Gross Plant}} \leq b14$$

$$\frac{x104}{x206} \leq b14$$

15. Dividend Payout Ratio:

$$\frac{\text{Dividends on Common}}{\text{Net Income on Common}} \geq b15$$

$$\frac{x114}{x113} \geq b15$$

16. Capital Expenditure to Gross Plant:

$$\frac{\text{Change in Gross Plant}}{\text{Gross Plant at time t-1}} \geq b16$$

$$\frac{x206_t - x206_{t-1}}{x206_{t-1}} \geq b16$$

C. ACTIVITY RATIOS:

17. Cash Velocity:

$$\frac{\text{Sales}}{\text{Cash}} \geq b17$$

$$\frac{x101}{x201} \geq b17$$

18. Inventory Turnover:

$$\frac{\text{Sales}}{\text{Inventory}} \geq b18$$

$$\frac{x101}{x203} \geq b18$$

19. Fixed Assets Turnover:

$$\frac{\text{Sales}}{\text{Net Plant}} \geq b19$$

$$\frac{x101}{x208} \geq b19$$

20. Average Collection Period:

$$\frac{\text{Accounts Receivable } x360}{\text{Sales}} \leq b20$$

$$\frac{360\ x202}{x101} \leq b20$$

21. Total Assets Turnover:

$$\frac{\text{Sales}}{\text{Total Assets}} \geq b21$$

$$\frac{x101}{x210} \geq b21$$

D. PROFITABILITY RATIOS:

22. Gross Operating Margin:

$$\frac{\text{Gross Operating Income}}{\text{Sales}} \geq b22$$

$$\frac{x101 - x102 - x103}{x101} \geq b22$$

23. Net Operating Margin:

$$\frac{\text{Net Operating Income}}{\text{Sales}} \geq b23$$

$$\frac{x105}{x101} \geq b23$$

24. Sales Margin:

$$\frac{\text{Net Income}}{\text{Sales}} \geq b24$$

$$\frac{x111}{x101} \geq b24$$

25. Productivity of Assets:

$$\frac{\text{Net Operating Income - Taxes}}{\text{Total Assets}} \geq b25$$

$$\frac{x105 - x110}{x210} \geq b25$$

26. Return on Net Worth:

$$\frac{\text{Net Income on Common Stock Equity}}{\text{Net Worth}} \geq b26$$

$$\frac{x113}{x218 + x219 + x220} \geq b26$$

27. Operating Income to Net Plant:

$$\frac{\text{Net Operating Income}}{\text{Net Plant}} \geq b27$$

$$\frac{x105}{x208} \geq b27$$

28. Operating Expense Ratio:

$$\frac{\text{Operating Expense}}{\text{Sales}} \leq b28$$

$$\frac{x102 + x103}{x101} \leq b28$$

The system of twenty-eight constraints per time period representing the financial ratios is written in the following form.

1. $x204_t - b1\ x214_t \geq 0$
2. $x204_t - x203_t - b2\ x214_t \geq 0$
3. $x203_t - b3\ x204_t + b3\ x214_t \leq 0$
4. $x201_t - b4\ x204_t \geq 0$
5. $x201_t - b5\ x210_t \geq 0$
6. $x204_t - b6\ x210_t \geq 0$
7. $x206_t - b7\ x210_t \leq 0$
8. $x208_t - b8\ x210_t \leq 0$
9. $x214_t - b9\ x210_t \leq 0$
10. $x214_t + x215_t + x216_t - b10\ x210_t \leq 0$
11. $x105_t + x106_t - x107_t - b11\ x108_t \geq 0$
12. $x214_t - b12\ x218_t - b12\ x219_t - b12\ x220_t \leq 0$
13. $x208_t - b13\ x218_t - b13\ x219_t - b13\ x220_t \leq 0$
14. $x104_t - b14\ x206_t \leq 0$
15. $x114_t - b15\ x113_t \geq 0$

16. $x206_t - x206_{t-1} - b16\ x206_{t-1} \geq 0$

17. $x101_t - b17\ x201_t \geq 0$

18. $x101_t - b18\ x203_t \geq 0$

19. $x101_t - b19\ x208_t \geq 0$

20. $360x202_t - b20\ x101_t \leq 0$

21. $x101_t - b21\ x210_t \geq 0$

22. $(1-b22)x101_t - x102_t - x103_t \geq 0$

23. $x105_t - b23\ x101_t \geq 0$

24. $x111_t - b24\ x101_t \geq 0$

25. $x105_t - x110_t - b25\ x210_t \geq 0$

26. $x113_t - b26\ x218_t - b26\ x219_t - b26\ x220_t \geq 0$

27. $x105_t - b27\ x208_t \geq 0$

28. $x102_t + x103_t - b28\ x101_t \leq 0$

for all t=1, ... ,T.

Substituting

1. $x105_t = x101_t - x102_t - x103_t - x104_t - x104a_t$

2. $x109_t = x101_t - x102_t - x103_t - x104_t - x104a_t + x106_t - x107_t - x108_t$

3. $x113_t = x101_t - x102_t - x103_t - x104_t - x104a_t + x106_t - x107_t - x108_t - x110_t - x112_t$

4. $x204_t = x201_t + x202_t + x203_t$

5. $x208_t = x206_t - x207_t$

6. $x209_t = x209a_t - x209b_t$

7. $x210_t = x201_t + x202_t + x203_t + x205_t + x206_t - x207_t + x209a_t - x209b_t$

8. $x214_t = x211_t + x212_t + x213_t$

we obtain

1. $x201_t + x202_t + x203_t - b1x211_t - b1x212_t - b1x213_t \geq 0$

2. $x201_t + x202_t - b2x211_t - b2x212_t - b2x213_t \geq 0$

3. $- b3x201_t - b3x202_t + (1 - b3)\, x203_t + b3x211_t + b3x212_t + b3x213_t \leq 0$

4. $(1 - b4)\, x201_t - b4x202_t - b4x203_t \geq 0$

5. $(1 - b5)\, x201_t - b5x202_t - b5x203_t - b5x205_t - b5x206_t + b5x207_t - b5x209a_t + b5x209b_t \geq 0$

6. $(1 - b6)\, x201_t + (1 - b6)\, x202_t + (1 - b6)\, x203_t - b6x205_t - b6x206_t + b6x207_t - b6x209a_t + b6x209b_t \geq 0$

7. $- b7x201_t - b7x202_t - b7x203_t - b7x205_t + (1 - b7)\, x206_t + b7x207_t - b7x209a_t + b7x209b_t \leq 0$

8. $- b8x201_t - b8x202_t - b8x203_t - b8x205_t + (1 - b8)\, x206_t - (1 - b8)\, x207_t - b8x209a_t + b8x209b_t \leq 0$

9. $- b9x201_t - b9x202_t - b9x203_t - b9x205_t - b9x206_t + b9x207_t - b9x209a_t + b9x209b_t + x211_t + x212_t + x213_t \leq 0$

10. $- b10x201_t - b10x202_t - b10x203_t - b10x205_t - b10x206_t + b10x207_t - b10x209a_t + b10x209b_t + x214_t + x215_t + x216_t \leq 0$

11. $x101_t - x102_t - x103_t - x104_t - x104a_t + x106_t - x107_t$
$- b11x108_t \geq 0$

12. $x211_t + x212_t + x213_t - b12x218_t - b12x219_t - b12x220_t \leq 0$

13. $x206_t - x207_t - b13x218_t - b13x219_t - b13x220_t \leq 0$

14. $x104_t - b14x206_t \leq 0$

15. $- b15x101_t + b15x102_t + b15x103_t + b15x104_t + b15x104a_t$
$- b15x106_t + b15x107_t + b15x108_t + b15x110_t$
$+ b15x112_t + x114_t \geq 0$

16. $x206_t - (1 + b16)\, x206_{t-1} \geq 0$

17. $x101_t - b17x201_t \geq 0$

18. $x101_t - b18x203_t \geq 0$

19. $x101_t - b19x206_t + b19x207_t \geq 0$

20. $- b20x101_t + 360x202_t \leq 0$

21. $x101_t - b21x201_t - b21x202_t - b21x203_t - b21x205_t$
$- b21x206_t + b21x207_t - b21x209a_t$
$+ b21x209b_t \geq 0$

22. $(1 - b22)\, x101_t - x102_t - x103_t \geq 0$

23. $(1 - b23)\, x101_t - x102_t - x103_t - x104_t - x104a_t \geq 0$

24. $(1 - b24)\, x101_t - x102_t - x103_t - x104_t - x104a_t$
$+ x106_t - x107_t - x108_t - x110_t \geq 0$

25. $x101_t - x102_t - x103_t - x104_t - x104a_t - x110_t - b25x201_t$
$- b25x202_t - b25x203_t - b25x205_t - b25x206_t$
$+ b25x207_t - b25x209a_t + b25x209b_t \geq 0$

26. $x101_t - x102_t - x103_t - x104_t - x104a_t + x106_t - x107_t$
$- x108_t - x110_t - x112_t - b26x218_t$
$- b26x219_t - b26x220_t \geq 0$

$$27.\quad x101_t - x102_t - x103_t - x104_t - x104a_t - b27x206_t + b27x207_t \geq 0$$

$$28.\quad - b28x101_t + x102_t + x103_t \leq 0$$

The T constraints for the capital expenditure to gross plant ratio (number 16) can be simplified into one constraint equation,

$$x206_t - (1 + b16)\, x206_{t-1} \geq 0, \text{ for all } t=1, \ldots, T.$$

Rewriting the constraint, we obtain

$$x206_t \geq (1 + b16)\, x206_{t-1} \quad \text{for all } t=1, \ldots, T.$$

If $(1 + b16)\, x206_{t-1}$ is substituted for each occurrence of $x206_t$ in the system of T constraints, the inequality requirements are not violated and we obtain

$$x206_T \geq (1 + b16)^T\, x206_0.$$

Mathematical Formulation of the Entire System

The financial system can now be formalized and financial activities can be combined with the formulation of the objective function and the constraint system to result in the mathematical representation of the management control system simulator to be implemented in the next chapter.

$$1.\quad \text{Maximize } Z' = \sum_{t=1}^{T-1} [g(1 + g)^{T-t-1}\, x220_t + (1 + g)^{T-t}\, x114_t] + x220_T + x114_T, \quad T \geq 2$$

subject to

$$2.\quad x211_T + \sum_{t=1}^{T} x308_t = x211_0$$

$$3.\quad x215_T + \sum_{t=1}^{T} x309_t = x215_0$$

4. $$x216_T + \sum_{t=1}^{T} x310_t = x216_0$$

5. $$\sum_{t=1}^{T} x302_t - \sum_{t=1}^{T} d9x101_t - \sum_{t=1}^{T-1} x202_t = x202_0$$

6. $$x202_T - \sum_{t=1}^{T} (x101_t - x302_t) = x202_0$$

7. $$x203_T + \sum_{t=1}^{T} (x102_t - x316_t - x317_t) = x203_0$$

8. $$x205_T - \sum_{t=1}^{T} x303_t = x205_0$$

9. $$x207_T - \sum_{t=1}^{T} x104_t = x207_0$$

10. $$x212_T + \sum_{t=1}^{T} (x301_t - x316_t) = x212_0$$

11. $$x213_T - \sum_{t=1}^{T} (x110_t - x307_t) = x213_0$$

12. $$x201_T + \sum_{t=1}^{T} (x103_t - x106_t + x107_t + x108_t + x112_t + x114_t + x301_t - x302_t + x303_t + x307_t + x308_t + x309_t + x310_t + x304_t + x311_t - x312_t x313_t - x314_t x315_t + x317_t) = x201_0$$

13. $$x209b_T - \sum_{t=1}^{T} x104a_t = x209b_0$$

14. $$x206_T - \sum_{t=1}^{T} x304_t = x206_0$$

15. $x209a_T - \sum_{t=1}^{T} x311_t = x209a_0$

16. $x217_T - \sum_{t=1}^{T} x312_t x313_t = x217_0$

17. $x218_T - \sum_{t=1}^{T} d11x314_t = x218_0$

18. $x219_T - \sum_{t=1}^{T} (x314_t 315_t - d11x314_t) = x219_0$

19. $x220_T - \sum^{T} (x101_t - x102_t - x103_t - x104_t - x104a_t + x106_t - x107_t - x108_t - x110_t - x112_t - x114_t) = x220_0$

20. $x204_t - x201_t - x202_t - x203_t = 0$

21. $x208_t - x206_t + x207_t = 0$

22. $x209_t - x209a_t + x209b_t = 0$

23. $x210_t - x204_t - x205_t - x208_t - x209_t = 0$

24. $x214_t - x211_t - x212_t - x213_t = 0$

25. $x210_t - x214_t - x215_t - x216_t - x217_t - x218_t - x219_t - x220t = 0$

26. $- x201_t - x202_t - x203_t + b1x211_t + b1x212_t + b1x213_t + s1_t = 0$

27. $- x201_t - x202_t + b2x211_t + b2x212_t + b2x213_t + s2_t = 0$

28. $- b3x201_t - b3x202_t + (1 - b3)\, x203_t + b3x211_t + b3x212_t + b3x213_t + s3_t = 0$

29. $- (1 - b4)\, x201_t + b4x202_t + b4x203_t + s4_t = 0$

30. $- (1 - b5)\, x201_t + b5x202_t + b5x203_t + b5x205_t + b5x206_t - b5x207_t + b5x209a_t - b5x209b_t + s5_t = 0$

31. $- (1 - b6)\, x201_t - (1 - b6)\, x202_t - (1 - b6)\, x203_t + b6x205_t + b6x206_t - b6x207_t + b6x209a_t - b6x209b_t + s6_t = 0$

32. $- b7x201_t - b7x202_t - b7x203_t - b7x205_t + (1 - b7)\, x206_t + b7x207_t - b7x209a_t + b7x209b_t + s7_t = 0$

33. $- b8x201_t - b8x202_t - b8x203_t - b8x205_t + (1 - b8)\, x206_t - (1 - b8)\, x207_t - b8x209a_t + b8x209b_t + s8_t = 0$

34. $- b9x201_t - b9x202_t - b9x203_t - b9x205_t - b9x206_t + b9x207_t - b9\, x209a_t + b9x209b_t + x211_t + x212_t + x213_t + s9_t = 0$

35. $- b10x201_t - b10x202_t - b10x203_t - b10x205_t - b10x206_t + b10x207_t - b10x209a_t + b10x209b_t + x214_t + x215_t + x216_t + s10_t = 0$

36. $- x101_t + x102_t + x103_t + x104_t + x104a_t - x106_t + x107_t + b11x108_t + s11_t = 0$

37. $x211_t + x212_t + x213_t - b12x218_t - b12x219_t - b12x220_t + s12_t = 0$

38. $x206_t - x207_t - b13x218_t - b13x219_t - b13x220_t + s13_t = 0$

39. $x104_t - b14x206_t + s14_t = 0$

40. $+ b15x101_t - b15x102_t - b15x103_t - b15x104_t - b15x104a_t + b15x106_t - b15x107_t - b15x108_t - b15x110_t - b15x112_t - x114_t + s15_t = 0$

41. $- x206_t + (1 - b16)\, x206_{t-1} + s16_t = 0$

42. $-x101_t + b17x201_t + s17_t = 0$

43. $-x101_t + b18x203_t + s18_t = 0$

44. $-x101_t + b19x206_t - b19x207_t + s19_t = 0$

45. $-b20x101_t + 360x202_t + s20_t = 0$

46. $-x101_t + b21x210_t + b21x202_t + b21x203_t + b21x205_t$
$+ b21x206_t - b21x207_t + b21x209a_t - b21x209b_t + s21_t = 0$

47. $-(1 - b22)\, x101_t + x102_t + x103_t + s22_t = 0$

48. $-(1 - b23)\, x101_t + x102_t + x103_t + x104_t$
$+ x104a_t + s23_t = 0$

49. $-(1 - b24)\, x101_t + x102_t + x103_t + x104_t + x104a_t$
$- x106_t + x107_t + x108_t + x110_t + s24_t = 0$

50. $-x101_t + x102_t + x103_t + x104_t + x104a_t + x110_t$
$+ b25x201_t + b25x202_t + b25x203_t + b25x205_t$
$+ b25x206_t - b25x207_t + b25x209a_t - b25x209b_t + s25_t = 0$

51. $-x101_t + x102_t + x103_t + x104_t + x104a_t - x106_t$
$+ x107_t + x108_t + x110_t + x112_t + b26x218_t$
$+ b26x219_t + b26x220_t + s26_t = 0$

52. $-x101_t + x102_t + x103_t + x104_t + x104a_t + b27x206_t$
$- b27x207_t + s27_t = 0$

53. $-b28x101_t + x102_t + x103_t + s28_t = 0$

for all t=1, ..., T.

The above system of fifty-three equations extending over the planning period T must now be incorporated into a computer based model. The man-machine model which will have as its basis the above mathematical formulation of the financial system will be discussed in the following chapter.

CHAPTER IV

THE MAN-MACHINE MODEL

System Definition

The mathematical model specified in Chapter III represents a set of relationships that react and/or interact with the conditions imposed by the user of the system and the conditions imbedded within the system in the form of a set of financial ratio standards. The model is fully deterministic and does not rely on probabilistic procedures. Furthermore, the model is dynamic because simulation outcomes are time dependent.

As such, the model has been incorporated into a computer system which serves as a management decision tool in financial management planning and control. With respect to financial planning, Johnson (1959, p. 53) points out that "...plans must fit the financial capability of the concern." He goes on to say that "the financial manager must therefore know how to go about analyzing the concern's position and estimating its capabilities."

The proposed model has this financial planning and control process as its object. Emphasis is, however, placed on examining the interdependent nature of the model simulator to determine the reactions from introducing the financial plan of a specific operational level into the model. The process of arriving at the latter plan, say, a plan for doubling sales over a five-year period, is not included in the simulation. The model accepts the plan for achieving this sales goal and will cause it to interact with the total financial system for the purpose of determining the

firm's capability for achieving this specific goal. Hence, the necessity for making other planning studies in the organization remains, and the model simulator can trigger other levels of decision making. The simulator will attempt to discover what is necessary to meet a specified target, but leaves the task of how to reach this target to the corresponding organizational unit such as the sales department. In this respect, the model serves both the planning and the control function of the top level manager because it seeks to establish compatibility of all sub-analyses with the entire financial system and activities of the firm. Individual plans are brought together and are then tested simultaneously. The strategy underlying the use of the model then becomes the following two-step procedure:

1. A specific plan is introduced into the model.
2. The plan is tested to determine if it is feasible with respect to all other financial activities and the financial position of the firm.

A prerequisite for the effective simulation is that the model represents the real world, that is, the actual financial activities and position of the firm, and that the model can be used to test this state of reality. For this reason, abstract relationships have been avoided whenever possible. When simulating the financial system of the firm, the manager is faced with making interdependent decisions in a dynamic environment.

The financial interactive planning simulator has been implemented on a time sharing computer system. The mathematical model has been

translated into FORTRAN code which, in combination with input data handling, report generation and conversational interaction procedures, represents the programming system. In implementing the computer programs, emphasis was placed on developing all procedures in such fashion that decision making by exception could be employed by the user of the system. In other words, the assumption is made that all data stored in the computer at any given time become the input to the current period's simulation process unless the decision maker intervenes and changes any or all data which become input to the simulation process. Furthermore, the computer system offers the flexibility to the decision maker of repeating the simulation of a given planning period as many times as he desires without affecting the overall result of the simulation process. The manager can, therefore, make a single decision, cause the system to simulate a planning period based on the single decision and hold all other variables fixed. This gives him the ability to test the sensitivity of this single decision on the entire operating process and the resultant financial position of the firm at the end of that time period.

The general system flow is depicted in Figure 4.1. Initially, the balance sheet data for the time period immediately preceding the first simulated planning period are fed into the computer. Hence, the simulation process will be based on the actual financial position of the firm to be simulated. Secondly, the computer program logic requires that all decision values, exogenous variable data and financial ratio standards be fed into the computer. It should be pointed out that the values of these three types of data could at this point be arbitrary

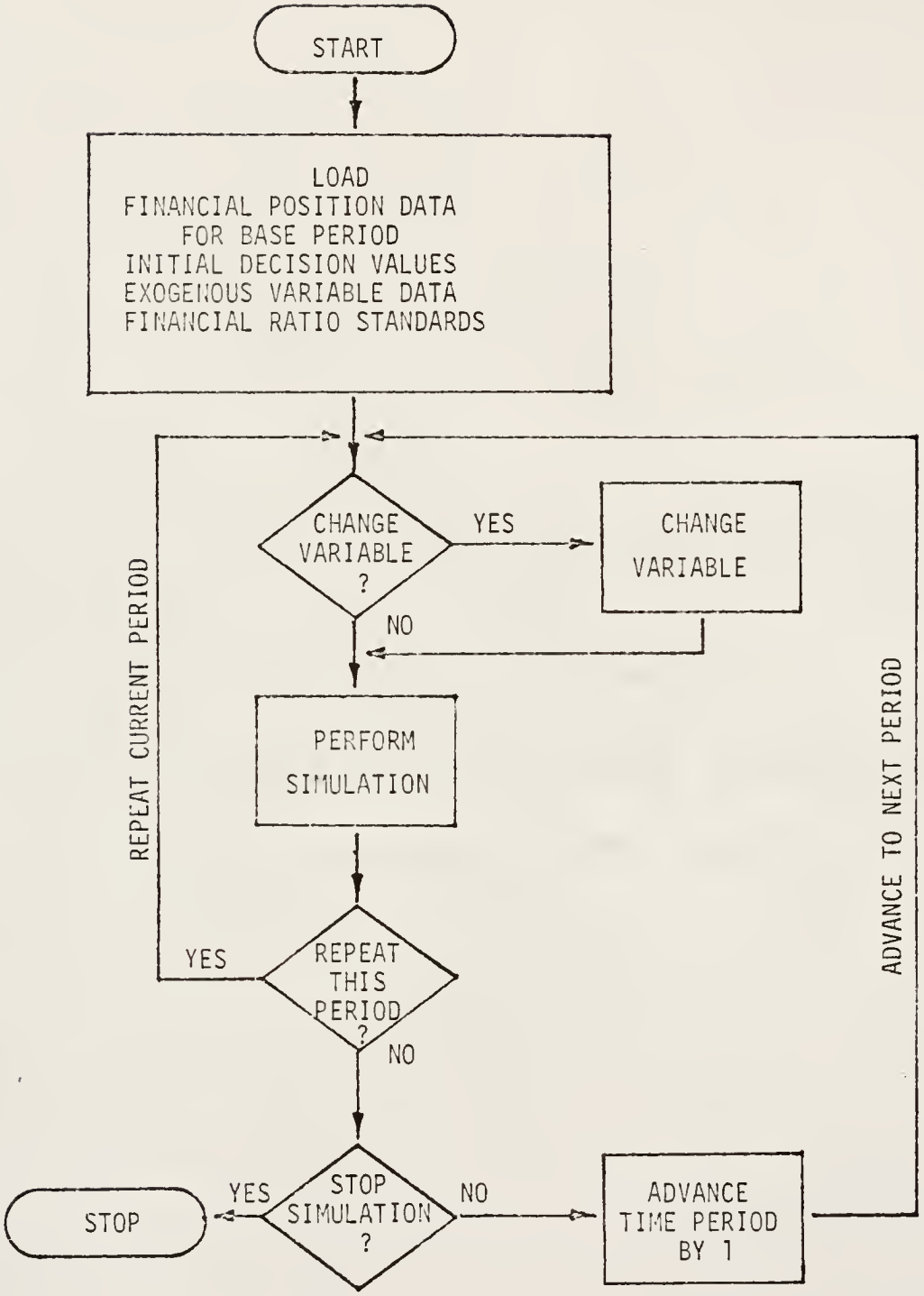

Fig. 4.1. General system flow: management control simulator.

because they are subject to change and can be modified by the user of the system prior to the execution of the simulation for the first planning period. Indeed, the next step in the system logic is the question by the computer to the decision maker if the user of the system desires to change any or all variables except the data representing the balance sheet for the base period. After all desired changes have been made by the decision maker, the simulation of the financial activities of the firm goes into effect. The next step offers the user the opportunity to repeat the simulation process for the current period. The purpose of the repeat is to change one or more variables and determine the outcome of this change on the financial operating results of the firm as well as the result in the financial position. If the decision is made not to repeat the simulation of the present period, the user has now the opportunity to terminate the entire simulation process. An alternate decision at this point is to advance to the next planning period and repeat the simulation process for the following planning period. A given planning period can be repeated as many times as desired and as many planning periods as are desired can be simulated sequentially. Hence, the decision maker has the opportunity to extend the planning horizon over as many planning periods as he wishes.

The Input/Output Elements of the System

The input to the simulation process consists of three types of data:

1. the initial financial position of the firm to be simulated in the form of balance sheet data for the base period,

2. manager controlled variables, and
3. computer controlled variables.

The simulation process produces the following outputs:

1. input decision comparisons,
2. the value of the objective function,
3. the sensitivity analysis,
4. schedule of changes in working capital,
5. statement of sources and uses of funds,
6. the income statement,
7. the balance sheet,
8. a comparative analysis of income statement and balance sheet activities, and
9. the financial ratio analysis.

The manager controlled variables require specific enumeration because they are subject to the manager's rational decision making. The manager controlled variables consist of the following major types of variables and their respective elementary variables:

1. All exogenous variables
2. All financial ratio standards
3. Income statement variables:
   a. Sales
   b. Cost of Goods Sold
   c. Selling and Administrative Expense
   d. Nonoperating Expense
   e. Dividends on Preferred Stock
   f. Dividends on Common Stock

4. Other variables:

   a. Purchase (or Sale) of Securities

   b. Purchase (or Sale) of Fixed Assets

   c. Nonoperating Income other than Interest Earned

   d. Short Term Loan Payment on Principal (or Receipt of Loan)

   e. Long Term Debt Unsubordinated Payment on Principal (or Receipt of Loan)

   f. Long Term Debt Subordinated Payment on Principal (or Receipt of Loan)

   g. Acquisition (or Sale) of Intangible Assets

   h. Number of Additional Shares of Preferred Stock Issued

   j. Number of Additional Shares of Common Stock Issued

   k. Price per Share of Common Stock

   l. Production Cost on Trade Credit

   m. Other Production Expenses

The input/output elements of the system are pictured in Figure 4.2. The status of the simulation process represents at any given time the value for the current simulation period and the financial position at the end of this period. In addition, the status of the previous simulation cycle is preserved which may or may not be the previous planning period. The system will always preserve the financial position of the previous planning period in order to determine the financial position at the end of the present planning period. For purposes of performing sensitivity analyses on the manager's decisions (the decision to change a variable from the value in the previous simulation cycle to a new value to be used in the present cycle), it is necessary to save the input decision from the previous

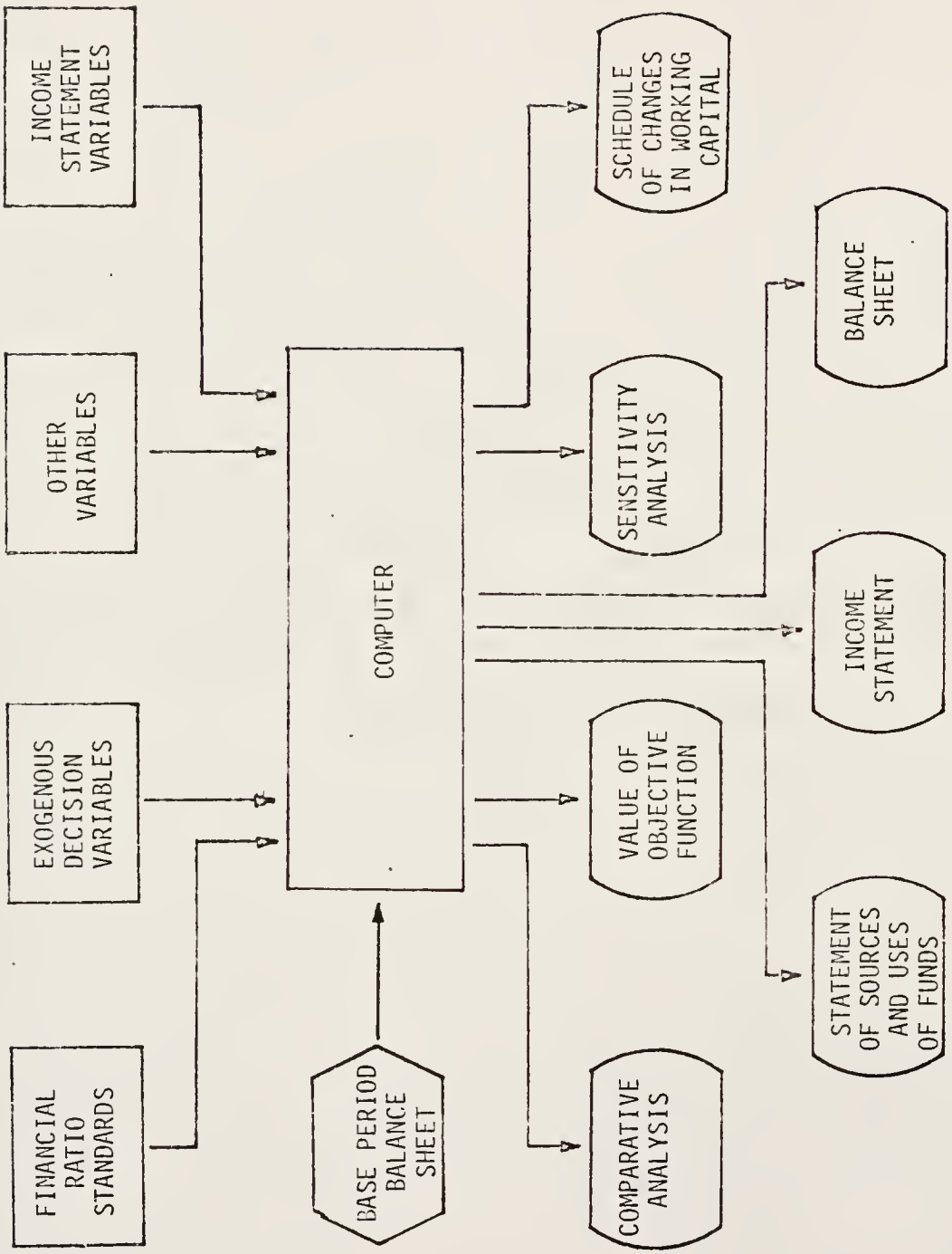

Fig. 4.2. The input/output elements of the system.

simulation cycle as well as the outcomes of the previous simulation cycle. None of these data are saved permanently. The only data that are saved permanently in the computer are the base period balance sheet, the initial financial ratio standards, the initial exogenous decision variable data, the initial other variable data and the initial income statement variable data which are also manager controlled.

The financial data which identify the position of the firm at the beginning of the first simulation period are identified and illustrated in Figure 4.3. The balance sheet for the base period thus becomes the starting point for the simulation of financial activities over the planning period.

An illustration of the exogenous variables stored in the computer is given in Figure 4.4. This illustration identifies the types of exogenous variables as well as examples of the initial input for these variables.

The input decisions consist of six income statement variables and thirteen other variables. The input decision variables are illustrated in Figure 4.5. They are initially stored in the computer for the sole purpose of having a set of input decision data but are subject to change prior to initiating the simulation for the first planning period.

The change of variable process is depicted in Figure 4.6. First, the decision maker has the choice of changing an input decision or leaving it as it was at the time of the last simulation process. The values of the input decisions remain unchanged unless they are modified by the manager in he change of variable process.

BALANCE SHEET AS OF 12-31-69 (AMOUNTS X 1000000.)

	$	CURR %	PREV %	CHG %	SALE %
CASH AND EQUIVALENTS	547.	12	12	0	10
ACCOUNTS RECEIVABLE	803.	17	17	0	15
INVENTORIES	190.	4	4	0	4
CURRENT ASSETS	1540.	33	33	0	29
SECURITIES	14.	0	0	0	0
GROSS PLANT	3507.	75	75	0	66
DEPRECIATION	408.	9	9	0	8
NET PLANT	3099.	66	66	0	58
GROSS INTANGIBLE ASSETS	8.	0	0	0	0
AMORTIZATION	0.	0	0	0	0
NET INTANGIBLE ASSETS	8.	0	0	0	0
TOTAL ASSETS	4661.	100	100	0	87
LOANS PAYABLE	33.	1	1	0	1
ACCOUNTS PAYABLE	533.	11	11	0	10
TAXES PAYABLE	313.	7	7	0	6
CURRENT LIABILITIES	879.	19	19	0	16
LONG TERM DEBT UNSUBORDINATED	0.	0	0	0	0
LONG TERM DEBT SUBORDINATED	459.	10	10	0	9
PREFERRED STOCK	0.	0	0	0	0
COMMON STOCK	272.	6	6	0	5
PAID IN SURPLUS	1039.	22	22	0	19
RETAINED EARNINGS	2012.	43	43	0	38
TOTAL LIABILITIES AND NET WORTH	4661.	100	100	0	87

Fig. 4.3. The balance sheet for the base period.

EXOG. VARIABLES FOR THE YEAR ENDING 12-31-69

RATE OF INTEREST EARNED ON SECURITIES	0.0700
RATE OF DEPRECIATION	0.1000
SCALE FACTOR FOR DOLLAR AMOUNTS	1000000.0000
RATE OF AMORTIZATION	0.2000
RATE OF INTEREST ON LOANS	0.0900
INTEREST RATE LONGTERM DEBT UNSUBORD.	0.0850
INTEREST RATE LONGTERM DEBT SUBORD.	0.0900
RATE OF PAYMENT ON ACCOUNTS PAYABLE	0.9000
RATE OF RECEIPT ON ACCOUNTS RECEIVABLE	0.8500
RATE OF PAYMENT ON TAXES PAYABLE	1.0000
PAR VALUE OF COMMON STOCK	5.0000
NO. OF SHARES OF COMMON OUTSTANDING	54.4482
NO. OF SHARES OF PREFERRED OUTSTANDING	0.0000
BASE YEAR	69.0000

Fig. 4.4. Exogenous variables.

INPUT DECISIONS FOR THE YEAR ENDING 12-31-69
(AMOUNTS X 1000000.)

SALES	5345.
COST OF GOODS SOLD	2060.
SELLING AND ADMINISTRATIVE EXPENSE	1114.
NONOPERATING EXPENSE	0.
DIVIDENDS ON PREFERRED STOCK	0.
DIVIDENDS ON COMMON STOCK	142.
PURCHASES(SALE) OF SECURITIES	0.
PURCHASE(SALE) OF FIXED ASSETS	0.
NONOPERATING INCOME OTHER THAN INTEREST	0.
SHORT TERM LOAN PAYMENT ON PRINCIPAL	0.
LONGTERM DEBT UNSUBORD. PAYM. TO PRINC.	0.
LONGTERM DEBT SUBORD. PAYM. TO PRINC.	0.
ACQUISITION(SALE) OF INTANGIBLE ASSETS	0.
NO. OF ADD. SHARES OF PREF. STOCK	0.
PRICE/SHARE OF PREFERRED STOCK	0.
NO. OF ADD. SHARES OF COMMON STOCK	0.
PRICE/SHARE OF COMMON STOCK	0.
PRODUCTION COST ON TRADE CREDIT	1200.
OTHER PRODUCTION EXPENSES	2000.

Fig. 4.5. Input decisions.

```
DO YOU WISH TO CHANGE A VARIABLE
?YES

TO IDENTIFY TYPE OF VARIABLE OR END OF CHANGE TYPE:
   NONE, EXOG, RATI, INCO, OR OTHE

VARIABLE TYPE
?OTHE

VARIABLE NO.
?16

VALUE
?120

PRODUCTION COST ON TRADE CREDIT 1200.0000 TO  120.0000  -89%

VARIABLE TYPE
?OTH

VARIABLE NO.
?17

VALUE
?100

VARIABLE TYPE INCORRECT - TRY AGAIN
VARIABLE TYPE
?OTHE

VARIABLE NO.
?17

VALUE
?100

OTHER PRODUCTION EXPENSES    2000.0000 TO     100.0000  -94%

VARIABLE TYPE
?NONE
```

Fig. 4.6. The change of variable process.

If the user decides to change a variable, he must identify the type of variable to be modified, which variable within the specified type he wishes to change and the new value of this variable. In response to this input, the computer will identify the changed variable value by printing the description of this variable, the value of the variable prior to the change, the new value and the percentage change from the previous value. The decision maker now has a record of his decision.

Upon completion of a simulation cycle, the computer will print the value of the objective function which is the value of the net income on the common stock equity extending to the planning horizon. The planning period covers the time period from the base period to the planning horizon itself. Figure 4.7 depicts the printout produced by the computer reporting the new value of the objective function.

Before the computer produces financial reports covering the just completed simulation cycle, the financial ratios are identified which have been exceeded in the current simulation. These financial ratios are ranked by the percentage deviation of the actual ratios from the financial ratio standards. Hence, in relative terms, the ratio with the most severe percentage deviation will be printed first. The least sensitive ratio will be printed last. This technique of ranking sensitive ratios does not guarantee that the ratio with the greatest deviation is the most critical ratio encountered in the simulation. This is not possible because no quantitative technique is available for ranking the ratios in this manner. However, the ranking offers the decision maker a quick and easy indication of the trends of his decision making and is therefore a valuable tool to

```
BEGINNING 12-31-69, THE VALUE OF THE NET INCOME
ON THE COMMON STOCK EQUITY COVERING A PLANNING PERIOD
OF  1 YEARS THROUGH 12-31-70 IS        944.
```

Fig. 4.7. The value of the objective function.

the decision maker in analyzing his performance. Hence, the relative importance of the ratios is not considered directly. Rather, a warning is initiated if standards are violated, and this calls for the objective evaluation by the manager.

Aside from ranking those financial ratios which exceed the ratio constraints, the sensitivity analysis will also rank those ratios which satisfy the ratio constraints by more than a specified percentage level. This ranking gives the manager the opportunity to identify those ratios which do not reach significant sensitivity levels because of the low standards specified.

In conjunction with the identification of those financial ratios which have been violated, or which satisfy standards by more than a specified percentage, the sensitivity analysis identifies the corresponding variables which constitute the definition of the ratio in question (Fig. 4.8). Furthermore, the sensitivity analysis determines from the financial sensitivity ratio matrix (Table 4.1) whether the given variable value should be increased or decreased in order to satisfy the financial ratio standard constraint. The numbers printed next to these recommendations identify the ratio to which this recommendation relates.

The first financial reports produced by the simulator are the schedule of changes in working capital and the statement of sources and uses of funds (Fig. 4.9 and 4.10).

The next financial report is the pro forma income statement. Besides reporting the dollar values of the income statement variables, the pro forma income statement also reports the percent of sale of

```
THE FOLLOWING RATIOS HAVE BEEN EXCEEDED BY THE PERCENTAGES INDICATED:
 RATIO(18) EXCEEDED BY    262%
 RATIO(16) EXCEEDED BY    100%


THE FOLLOWING RATIOS SATISFY STANDARDS BY MORE THAN  100%:
 RATIO( 2) SATISFIED BY  5040%
 RATIO(11) SATISFIED BY  2700%
 RATIO( 1) SATISFIED BY  1922%
 RATIO(27) SATISFIED BY   567%
 RATIO( 4) SATISFIED BY   486%
 RATIO( 5) SATISFIED BY   476%
 RATIO( 3) SATISFIED BY   286%
 RATIO(23) SATISFIED BY   132%
 RATIO(26) SATISFIED BY   129%
 RATIO(25) SATISFIED BY   113%
 RATIO(22) SATISFIED BY   103%
 RATIO(17) SATISFIED BY   100%


THE FOLLOWING VARIABLES CAUSE SENSITIVITY:
SALES
     INCR: 18
     DECR: 11 17 22 23 25 26 27
COST OF GOODS SOLD
     INCR: 11 22 23 25 26 27
SELLING AND ADMINISTRATIVE EXPENSE
     INCR: 11 22 23 25 26 27
DEPRECIATION
     INCR: 11 23 25 26 27
AMORTIZATION
     INCR: 11 23 25 26 27
NONOPERATING INCOME
     DECR: 11 26
NONOPERATING EXPENSE
     INCR: 11 26
INTEREST ON LOANS
     INCR: 11 26
FEDERAL AND STATE INCOME TAXES
     INCR: 25 26
DIVIDENDS ON PREFERRED STOCK
     INCR: 26
CASH AND EQUIVALENTS
     INCR: 17 25
     DECR:  1  2  3  4  5
ACCOUNTS RECEIVABLE
     INCR:  4  5 25
     DECR:  1  2  3
INVENTORIES
     INCR:  3  4  5 25
     DECR:  1 18
SECURITIES
     INCR:  5 25
GROSS PLANT
     INCR:  5 16 25 27
DEPRECIATION
     DECR:  5 25 27
GROSS INTANGIBLE ASSETS
     INCR:  5 25
AMORTIZATION
     DECR:  5 25
LOANS PAYABLE
     INCR:  1  2  3
ACCOUNTS PAYABLE
     INCR:  1  2  3
TAXES PAYABLE
     INCR:  1  2  3
COMMON STOCK
     INCR: 26
PAID IN SURPLUS
     INCR: 26
RETAINED EARNINGS
     INCR: 26
```

Fig. 4.8. Sensitivity analysis.

TABLE 4.1

THE FINANCIAL RATIO SENSITIVITY MATRIX

	Variable	Financial Ratios																									
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Income Statement	x101											1				2		1	1	1	1	1	1	1	1	1	1	1	1
	x102											2				1							2	2	2	2	2	2	2
	x103											2				1							2	2	2	2	2	2	2
	x104											2			2	1								2	2	2	2	2	
	x104a											2				1								2	2	2	2	2	
	x106											1				2								1	1		1		
	x107											2				1								2	2		2		
	x108											2				1								2	2		2		
	x110															1									2	2	2		
	x112															1									2		2		
	x114															1													
Balance Sheet	x201	1	1	1	1	1	1	1	1	1	1							2				2				2			
	x202	1	1	1	2	2	1	1	1	1	1										2	2				2			
	x203	1		2	2	2	1	1	1	1	1								2			2				2			
	x205					2	2	1	1	1	1											2				2			
	x206					2	2	2	2	1	1			2	1		1			2		2				2		2	
	x207					1	1	2	1	2	2			1						1		1				1		1	
	x209a					2	2	1	1	1	1											2				2			
	x209b					1	1	2	2	2	2											1				1			
	x211	2	2	2						2	2		2																
	x212	2	2	2						2			2																
	x213	2	2	2						2			2																
	x215										2																		
	x216										2																		
	x217																												
	x218												1	1													2		
	x219												1	1													2		
	x220												1	1													2		

1 = increase value of variable
2 = decrease value of variable

PRO FORMA SCHEDULE OF CHANGES IN WORKING CAPITAL
FOR THE YEAR ENDING 12-31-70 (AMOUNTS X 1000000.)

CHANGES IN CURRENT ASSETS	
CASH AND EQUIVALENTS	2121.
ACCOUNTS RECEIVABLE	-1.
INVENTORIES	-1840.
TOTAL	279.

CHANGES IN CURRENT LIABILITIES	
LOANS PAYABLE	0.
ACCOUNTS PAYABLE	-521.
TAXES PAYABLE	-313.
TOTAL	-834.

WORKING CAPITAL CHANGE	1113.

Fig. 4.9. Pro forma schedule of changes in working capital.

PRO FORMA STATEMENT OF SOURCES AND USES OF FUNDS
FOR THE YEAR ENDING 12-31-70 (AMOUNTS X 1000000.)

SOURCES

NET INCOME	944.
DEPRECIATION	310.
AMORTIZATION	2.
LONG TERM DEBT	0.
TOTAL	1255.

USES

GROSS PLANT INCREASE	0.
GROSS INTANGIBLE ASSET INCREASE	0.
DIVIDENDS ON PREFERRED STOCK	0.
DIVIDENDS ON COMMON STOCK	142.
WORKING CAPITAL INCREASE	1113.
TOTAL	1255.

Fig. 4.10. Pro forma statement of sources and uses of funds.

each income statement variable for the indicated planning period. In addition, this report also prints the percent of sale for all variables from the previous simulation cycle. The last column reports the percentage changes in the dollar values of the income statement variable from the previous simulation cycle to the current simulation cycle. It should be emphasized again that these comparisons are comparisons with the previous simulation cycle and not with the previous planning period. Because of these comparisons, the decision maker can analyze the impact of his decision more readily because his decision making rests on making a change in the input decisions from one simulation cycle to the next and not necessarily restrict his decision making from one planning period to the next. The pro forma income statement is illustrated in Figure 4.11.

The pro forma balance sheet reports the financial position of the firm at the end of the current simulation period. This report is shown in Figure 4.12. Here again, the financial position of the previous simulation cycle is used as the basis for reporting comparisons. The technique employed is identical to that described for the pro forma income statement. The only difference is in the calculation of the percentage relationships between balance sheet variables. Here, percentages are reported in relation to the total assets. The last column of the balance sheet represents a comparison of the balance sheet variables with the level of sales. These figures are percent of sales for each balance sheet account.

The final report produced by the simulator is the ratio analysis.

PRO FORMA INCOME STATEMENT
FOR THE YEAR ENDING 12-31-70 (AMOUNTS X 1000000.)

	$	CURR %	PREV %	CHG %
SALES	5345.	100	100	0
COST OF GOODS SOLD	2060.	39	39	0
SELLING AND ADMINISTRATIVE EXPENSE	1114.	21	21	0
DEPRECIATION	310.	6	6	0
AMORTIZATION	2.	0	0	0
NET OPERATING INCOME	1859.	35	35	0
NONOPERATING INCOME	0.	0	0	0
NONOPERATING EXPENSE	0.	0	0	0
INTEREST ON LOANS	44.	1	1	0
NET INCOME BEFORE TAXES	1815.	34	34	0
FEDERAL AND STATE INCOME TAXES	871.	16	16	0
NET INCOME	944.	18	18	0
DIVIDENDS ON PREFERRED STOCK	0.	0	0	0
NET INCOME ON COMMON STOCK	944.	18	18	0
DIVIDENDS ON COMMON STOCK	142.	3	3	0
NET INCOME TO RETAINED EARNINGS	802.	15	15	0

Fig. 4.11. Pro forma income statement.

PRO FORMA BALANCE SHEET AS OF 12-31-70 (AMOUNTS X 1000000.)

	$	CURR %	PREV %	CHG %	SALE %
CASH AND EQUIVALENTS	2668.	58	12	388	50
ACCOUNTS RECEIVABLE	802.	17	17	0	15
INVENTORIES	-1650.	-35	4	-967	-30
CURRENT ASSETS	1819.	39	33	18	34
SECURITIES	14.	0	0	0	0
GROSS PLANT	3507.	76	75	0	66
DEPRECIATION	718.	16	9	76	13
NET PLANT	2789.	60	66	-9	52
GROSS INTANGIBLE ASSETS	8.	0	0	0	0
AMORTIZATION	2.	0	0	0	0
NET INTANGIBLE ASSETS	6.	0	0	-19	0
TOTAL ASSETS	4629.	100	100	0	87
LOANS PAYABLE	33.	1	1	0	1
ACCOUNTS PAYABLE	12.	0	11	-97	0
TAXES PAYABLE	0.	0	7	-99	0
CURRENT LIABILITIES	45.	1	19	-94	1
LONG TERM DEBT UNSUBORDINATED	0.	0	0	0	0
LONG TERM DEBT SUBORDINATED	459.	10	10	0	9
PREFERRED STOCK	0.	0	0	0	0
COMMON STOCK	272.	6	6	0	5
PAID IN SURPLUS	1039.	22	22	0	19
RETAINED EARNINGS	2814.	61	43	40	53
TOTAL LIABILITIES AND NET WORTH	4629.	100	100	0	87

Fig. 4.12. Pro forma balance sheet.

This report is shown in Figure 4.13. The ratio analysis lists the twenty-eight financial ratios which are utilized in the sensitivity analysis. This report also prints the financial ratio standards which are the basis for determining the ranking of sensitive financial ratios. The actual ratios determined in the simulation are printed and their relationships to the financial ratios are indicated by the "less than" or "greater than" symbols. An asterisk or a plus sign preceding the symbol indicating the direction of the inequality identifies a ratio which is sensitive. The asterisk flags ratios which do not satisfy financial ratio standards. The plus sign identifies ratios which satisfy the ratio constraints by more than a specified percentage.

The System Logic

The program logic of the management planning and control simulator is based on the interaction of man and machine during the simulation process. This interaction will be carried out in the complementary mode, that is, assignment of tasks in the simulation process to the user and the computer will be such as to utilize the best capabilities in the execution of the simulation. This decision is based on the assumption that either the user or the computer represents one of the two mutually completing parts necessary in the effective simulation of financial management decisions. The logic of the simulation is strictly based on deterministic procedures and utilizes the computer primarily as an analytical tool and as a data manipulator for the purposes of accepting input decisions and presenting the results of a managerial decision in the form most useful to the manager. The decision maker, on the other hand, is called upon by the system logic to

RATIO ANALYSIS FOR THE YEAR ENDING 12-31-70

		ACTUAL		STANDARD
1	CURRENT RATIO	40.43	+>	2.00
2	QUICK RATIO	77.10	+>	1.50
3	INVENTORY TO WORKING CAPITAL	-.93	+<	0.50
4	CASH TO CURRENT ASSETS	1.47	+>	0.25
5	CASH TO TOTAL ASSETS	0.58	+>	0.10
6	CURRENT ASSETS TO TOTAL ASSETS	0.39	>	0.25
7	GROSS PLANT TO TOTAL ASSETS	0.76	<	0.85
8	NET PLANT TO TOTAL ASSETS	0.60	<	0.75
9	CURRENT LIABILITIES TO TOTAL ASSETS	0.01	<	0.25
10	DEBT TO TOTAL ASSETS	0.11	<	0.20
11	TIMES INTEREST EARNED	41.99	+>	1.50
12	CURRENT LIABILITIES TO NET WORTH	0.01	<	0.25
13	FIXED ASSETS TO NET WORTH	0.68	<	1.00
14	DEPRECIATION TO GROSS PLANT	0.09	<	0.25
15	DIVIDEND PAYOUT RATIO	0.15	>	0.10
16	CAPITAL EXPENDITURE TO GROSS PLANT	0.00	*>	0.10
17	CASH VELOCITY	2.00	+>	1.00
18	INVENTORY TURNOVER	-3.24	*>	2.00
19	FIXED ASSETS TURNOVER	1.92	>	1.00
20	AVERAGE COLLECTION PERIOD	54.00	<	60.00
21	TOTAL ASSETS TURNOVER	1.15	>	1.00
22	GROSS OPERATING MARGIN	0.41	+>	0.20
23	NET OPERATING MARGIN	0.35	+>	0.15
24	SALES MARGIN	0.18	>	0.10
25	PRODUCTIVITY OF ASSETS	0.21	+>	0.10
26	RETURN ON NET WORTH	0.23	+>	0.10
27	OPERATING INCOME TO NET PLANT	0.67	+>	0.10
28	OPERATING EXPENSE RATIO	0.59	<	0.70

Fig. 4.13. Ratio analysis.

decide on the actions to be taken which initiate the simulation process, which in turn results in the presentation of simulated operating results and the corresponding financial position. Furthermore, it will be the manager's task to react to the outcome of a simulation cycle by interpreting the results of his input decision or decisions and to modify his decision if an alternate decision is to be tested. The computer responds with the feed-back to these managerial decisions on the basis of the simultaneous interaction of all financial variables in the system. Hence, regardless of the type of decision made, the simulator will test this decision against all possible functional relationships in the system and alerts the user to areas which may become over-sensitive and require managerial attention. The flowchart depicted in Figure 4.14 represents the logical basis for the computer program. All steps outlined in the flowchart are carried out by the computer except that the user is required to interact for the purpose of deciding:

1. if a specific status report is to be printed;
2. if a given variable is to be changed;
3. if the simulation cycle for the current period is to be repeated with changes in input decision variables; and
4. if the next planning period is to be simulated.

The step-by-step outline of the program logic is given below. Actions by the computer are indicated by the letter C and the manager's actions are identified by the letter M.

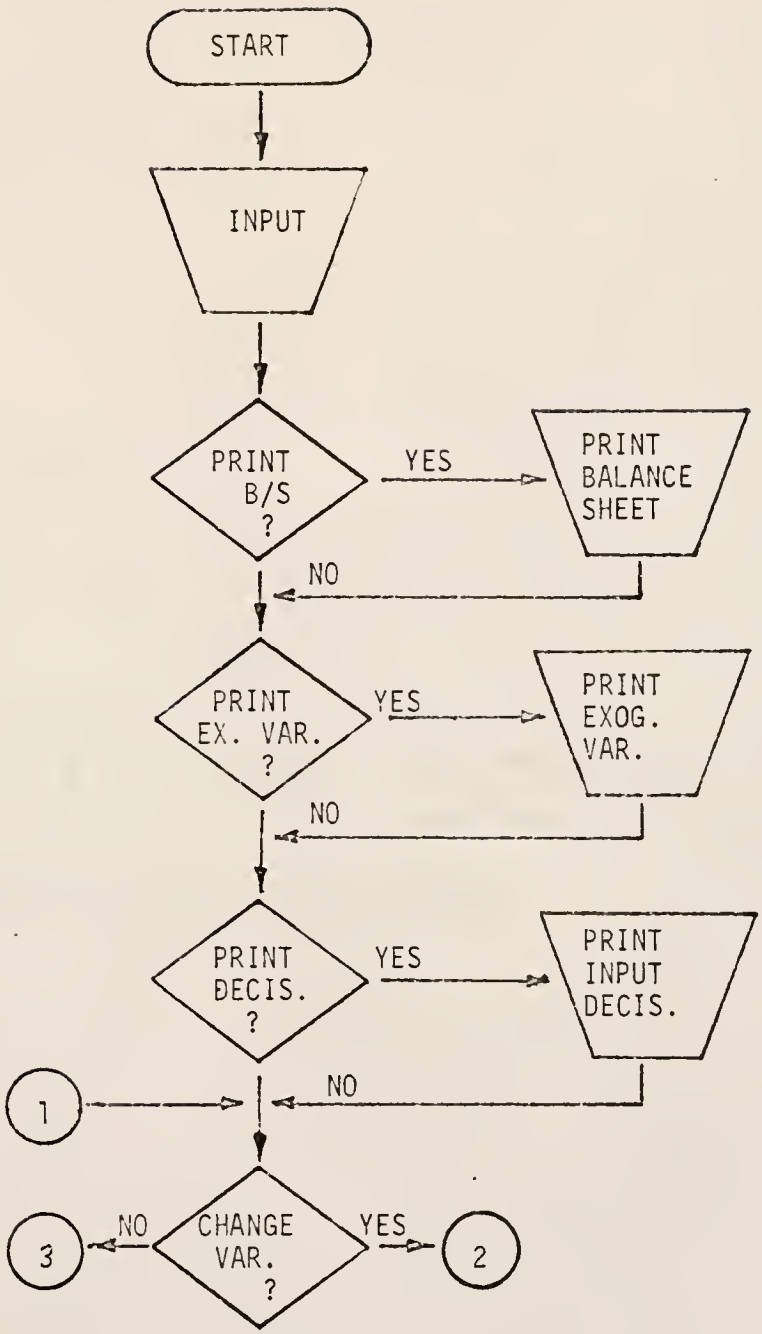

Fig. 4.14. Program logic of the management control simulator.

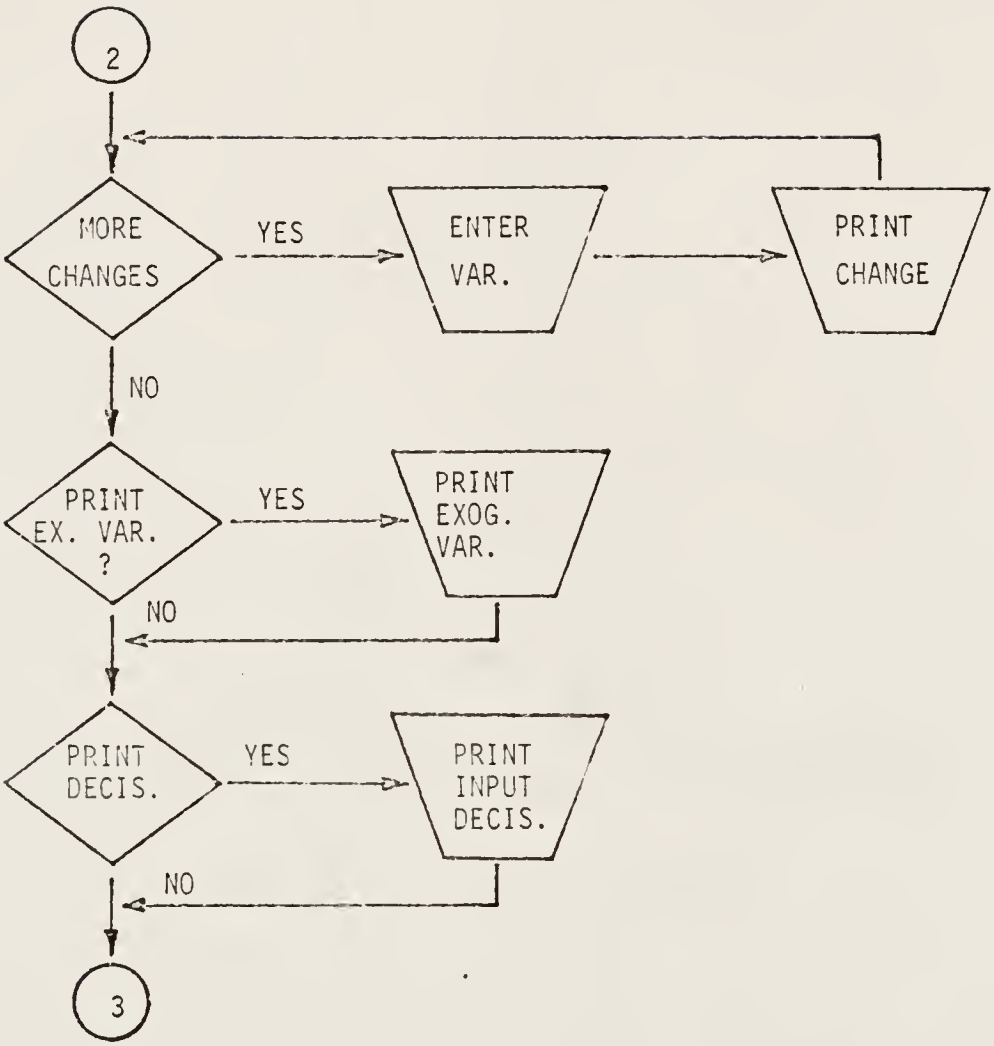

Fig. 4.14. (Continued)

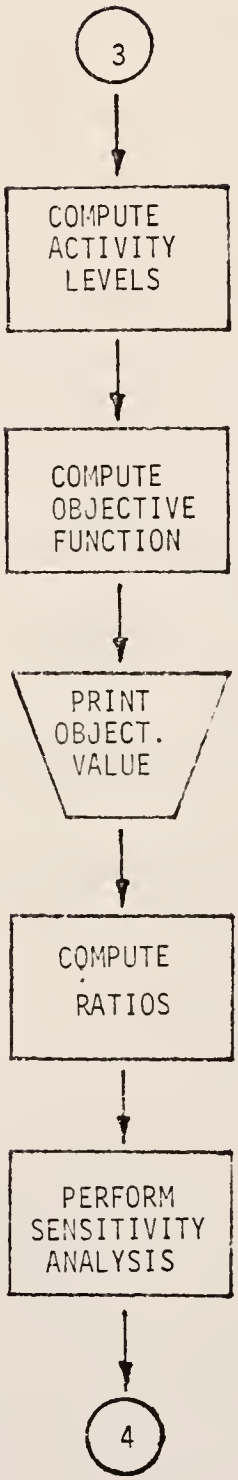

Fig. 4.14. (Continued)

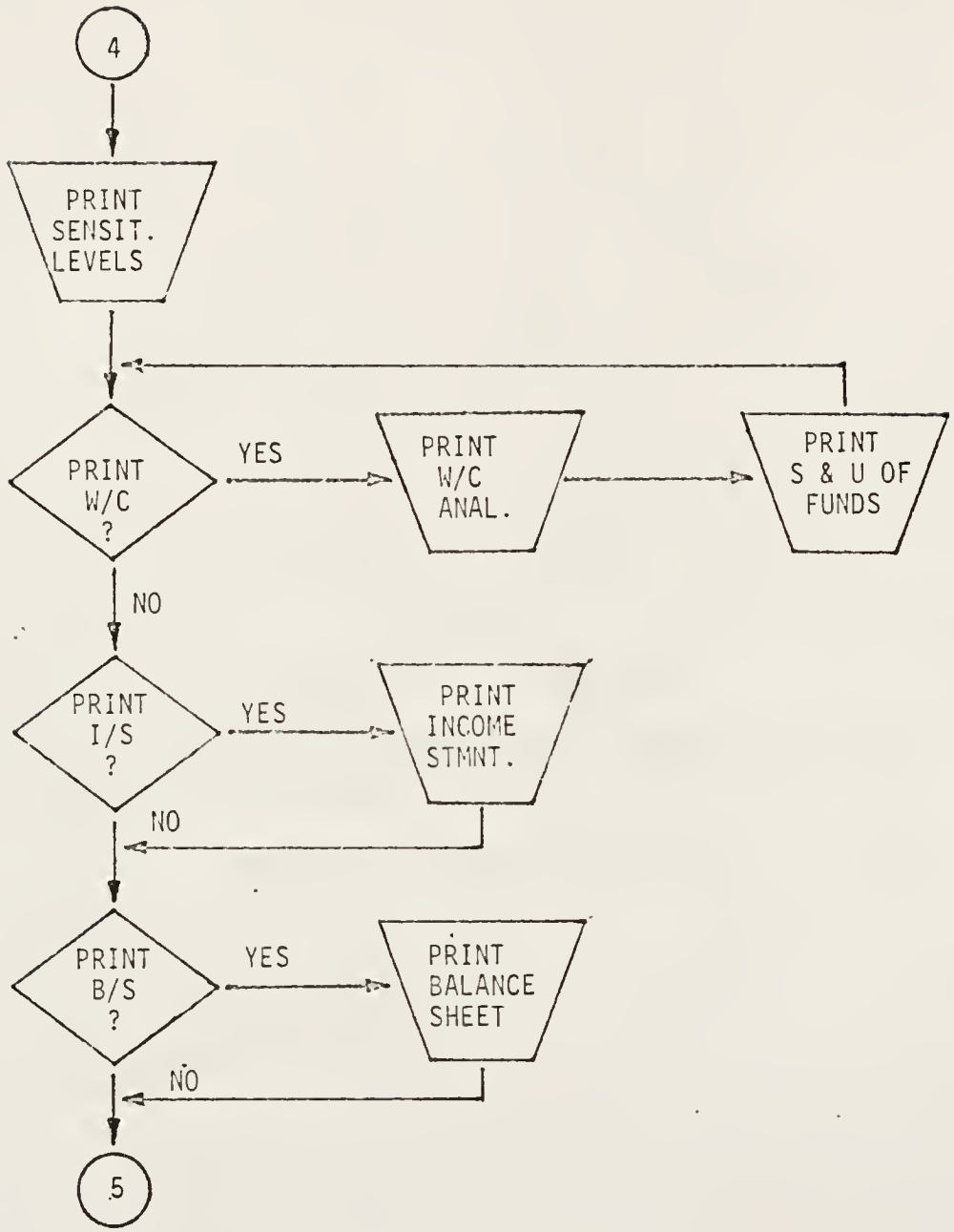

Fig. 4.14. (Continued)

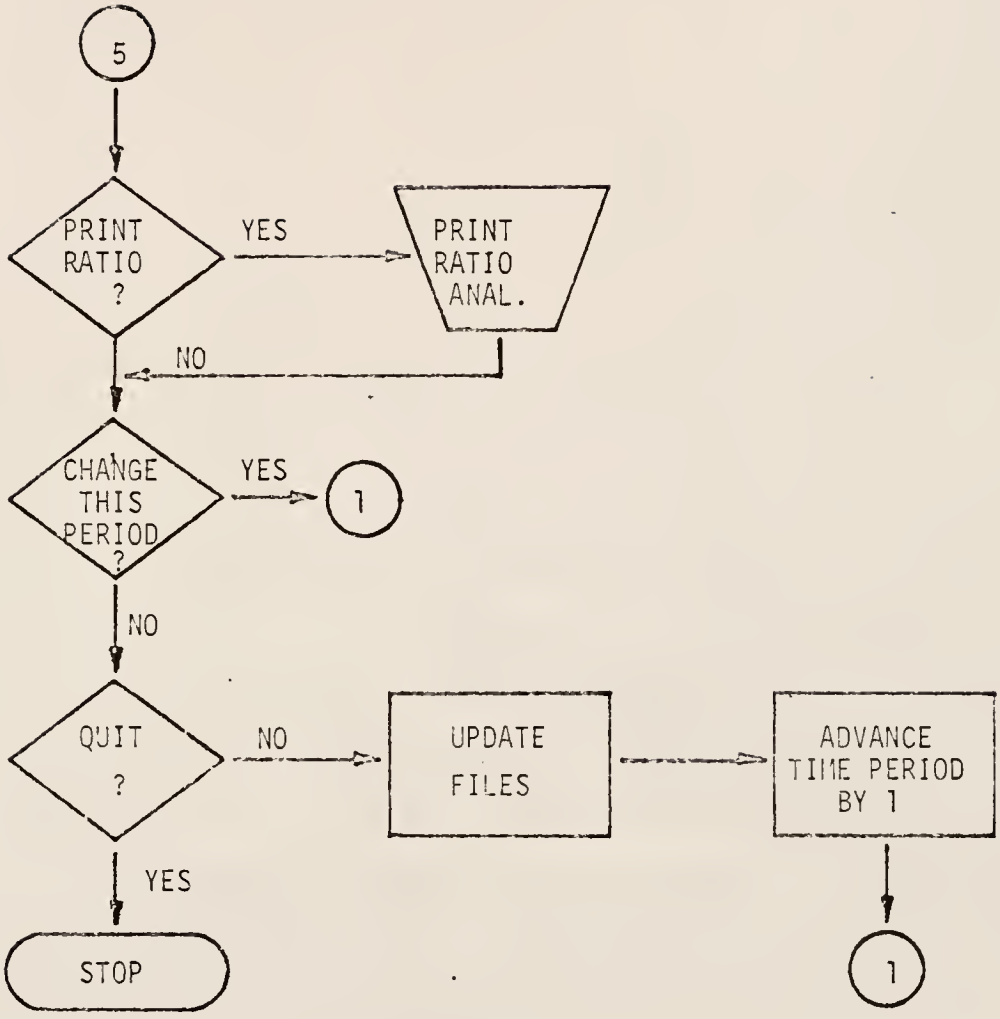

Fig. 4.14. (Continued)

Step-by-Step Outline of Program Logic:

M 1. Provide base period balance sheet data

M 2. Determine financial ratio standards

M 3. Determine exogenous decision data

M 4. Determine initial values for input decisions

C 5. Store base period balance sheet data in computer

C 6. Store financial ratio standards in computer

C 7. Store exogenous decision data in computer

C 8. Store initial values for input decisions in computer

C 9. Do you wish to print the balance sheet for the base period?

M 10. a. YES: Go to step 11

b. NO: Go to step 12

C 11. Print the base period balance sheet

C 12. Do you wish to print exogenous variables?

M 13. a. YES: Go to step 14

b. NO: Go to step 15

C 14. Print exogenous variables

C 15. Do you wish to print input decisions?

M 16. a. YES: Go to step 17

b. NO: Go to step 18

C 17. Print input decisions

C 18. Advance the planning horizon by one time period

C 19. Do you wish to change a variable?

M 20. a. YES: Go to step 21

b. NO: Go to step 33

C 21. Specify type of variable or indicate desire to stop changing variables

M 22. a. Desire to stop changing variables: Go to step 27

b. Variable type is specified

C 23. What is the value of the variable?

M 24. Value is entered

C 25. Print analysis of change in variable by comparing entered value against previous value

C 26. Go to step 21

C 27. Do you wish to print exogenous variables?

M 28. a. YES: Go to step 29

b. NO: Go to step 30

C 29. Print exogenous variables

C 30. Do you wish to print input decisions?

M 31. a. YES: Go to step 32

NO: Go to step 33

C 32. Print input decisions

C 33. Compute activity levels

C 34. Compute objective function

C 35. Print value of objective function

C 36. Compute financial ratios

C 37. Perform sensitivity analysis on ratios

C 38. Print sensitivity levels

C 39 Do you wish to print the working capital analysis and statement of sources and uses of funds?

M 40. a. YES: Go to step 41

b. NO: Go to step 42

C 41. Print working capital analysis and statement of sources and uses of funds

C 42. Do you wish to print the income statement?

M 43. a. YES: Go to step 44

b. NO: Go to step 45

C 44. Print the income statement

C 45. Do you wish to print the balance sheet?

M 46. a. YES: Go to step 47

b. NO: Go to step 48

C 47. Print the balance sheet

C 48. Do you wish to print the financial ratio analysis?

M 49. a. YES: Go to step 50

b. NO: Go to step 51

C 50. Print the financial ratio analysis

C 51. Do you wish to change present period results?

M 52. a. YES: Go to step 19

b. NO: Go to step 53

C 53. Do you wish to stop the simulation?

M 54. a. YES: Stop

b. NO: Go to step 55

C 55. Transfer current period balance sheet data to the previous period balance sheet file

C 56. Go to step 18

The Man-Machine Interactive Process

One final step remains in the process of demonstrating the feasibility of the man-machine interactive financial simulation model. It must now be shown how the manager can utilize the model and how the computer system responds to the manager's input decisions in the form of "what if" questions. Figure 4.15 represents a summarized printout of the responses from the computer for the problem of testing the effects of doubling sales for a hypothetical firm. The balance sheet from the previous period is printed at the beginning of the computer output. Then follow the input decisions which would normally be considered as input to the model. It is first desired to obtain the responses of the simulation from these input decisions prior to testing the feasibility of doubling the sales level. The system does not detect any inconsistencies except that the capital expenditure to gross plant ratio does not satisfy specified standards. This result is to be expected because no expenditures for fixed assets have been contemplated. Aside from the need to commit funds for capital expenditures to satisfy the requirements for annual investments in fixed assets, no other inconsistencies in the financial structure were expected. Now the decision is made to double sales and increase the cost of goods sold and the selling and administrative expenses correspondingly. This decision causes three financial ratios to be exceeded. Aside from the previously violated ratio, the inventory turnover ratio and the dividend payout ratio become sensitive in response to increasing the sales level. In order to improve the inventory turnover ratio as well as the dividend payout ratio, the decision is made to increase production and

also to increase the amount of dividends paid on common stock. Again, all financial ratios satisfy standards except the ratio of capital expenditure to gross plant. Special attention will now be given to the capital expenditure decision. First of all, an annual gross plant expansion of ten percent is necessary to satisfy predetermined standards. However, consideration must also be given to the need for additional fixed assets to correspond to the plan for doubling the level of sales. Previous experience indicates that approximately sixty-five percent of sales is necessary as a gross plant level. Production management informs the financial manager that a doubling of the gross plant account would be necessary in order to meet the needs for increased production. Hence, the decision is made to acquire additional fixed assets. These fixed assets are acquired by paying cash. The result of this decision is a strong indication that the level of cash on hand is insufficient to meet this capital expenditure. Therefore, it will now be determined if the use of long term debt will be feasible. However, the debt to total assets ratio and the fixed assets to net worth ratio become sensitive. The debt to total assets ratio becomes particularly sensitive. Hence, a test will be performed if part of the capital expenditure could be paid for with cash. This decision, in turn, causes the cash to total assets ratio and the current assets to total assets ratio to become sensitive. This is an indication that the level of cash does not permit the use of cash in acquiring fixed assets. Only one decision appears to remain, namely, that of reducing the level of additional fixed assets. This decision will now be tested. The resulting fixed assets to net worth

ratio still remains sensitive. However, the extent of the sensitivity is small and may be accepted by the financial manager. The debt to total assets ratio is still quite sensitive. If the manager accepts an increase in the financial leverage, the latest level of fixed asset addition is acceptable. In other words, if the manager can accept a weakening of the company's financial leverage, he can support the decision to acquire this latest level of fixed assets. It must, however, be realized that the new gross plant level does not correspond to the level requested by the production management as necessary for meeting the goal of sales management for doubling sales levels during the coming year. If the previously established financial leverage standard must be met, it is not feasible to increase sales by one hundred percent and at the same time have sufficient funds available to finance the expansion of production facilities.

The test case demonstrates how the financial manager can interact with the model by testing a financial proposal and determine the effect of changes in one variable on the levels of other financial variables. Hence, the financial manager can ask "what if" questions and identify the sensitivity of financial relationships. The constraint system consisting of financial ratio standards subject to upper and lower bounds is an effective tool in determining the sensitivity of the financial relationships. This model simulation, furthermore, demonstrates that it is not necessary to incorporate into the simulation model forecasting algorithms which determine levels of specific financial activities.

PRO FORMA BALANCE SHEET AS OF 12-31-69 (AMOUNTS X 1000000.)

	$	CURR %	PREV %	CHG %	SALE %
CASH AND EQUIVALENTS	547.	12	12	0	10
ACCOUNTS RECEIVABLE	803.	17	17	0	15
INVENTORIES	190.	4	4	0	4
CURRENT ASSETS	1540.	33	33	0	29
SECURITIES	14.	0	0	0	0
GROSS PLANT	3507.	75	75	0	66
DEPRECIATION	408.	9	9	0	8
NET PLANT	3099.	66	66	0	58
GROSS INTANGIBLE ASSETS	8.	0	0	0	0
AMORTIZATION	0.	0	0	0	0
NET INTANGIBLE ASSETS	8.	0	0	0	0
TOTAL ASSETS	4661.	100	100	0	87
LOANS PAYABLE	33.	1	1	0	1
ACCOUNTS PAYABLE	533.	11	11	0	10
TAXES PAYABLE	313.	7	7	0	6
CURRENT LIABILITIES	879.	19	19	0	16
LONG TERM DEBT UNSUBORDINATED	0.	0	0	0	0
LONG TERM DEBT SUBORDINATED	459.	10	10	0	9
PREFERRED STOCK	0.	0	0	0	0
COMMON STOCK	272.	6	6	0	5
PAID IN SURPLUS	1039.	22	22	0	19
RETAINED EARNINGS	2012.	43	43	0	38
TOTAL LIABILITIES AND NET WORTH	4661.	100	100	0	87

Fig. 4.15. Results of a simulation process.

INPUT DECISIONS FOR THE YEAR ENDING 12-31-69 (AMOUNTS X 1000000.)

SALES	5345.
COST OF GOODS SOLD	2060.
SELLING AND ADMINISTRATIVE EXPENSE	1114.
NONOPERATING EXPENSE	0.
DIVIDENDS ON PREFERRED STOCK	0.
DIVIDENDS ON COMMON STOCK	142.
PURCHASES(SALE) OF SECURITIES	0.
PURCHASE(SALE) OF FIXED ASSETS	0.
NONOPERATING INCOME OTHER THAN INTEREST	0.
SHORT TERM LOAN PAYMENT ON PRINCIPAL	0.
LONGTERM DEBT UNSUBORD. PAYM. TO PRINC.	0.
LONGTERM DEBT SUBORD. PAYM. TO PRINC.	0.
ACQUISITION(SALE) OF INTANGIBLE ASSETS	0.
NO. OF ADD. SHARES OF PREF. STOCK	0.
PRICE/SHARE OF PREFERRED STOCK	0.
NO. OF ADD. SHARES OF COMMON STOCK	0.
PRICE/SHARE OF COMMON STOCK	0.
PRODUCTION COST ON TRADE CREDIT	1200.
OTHER PRODUCTION EXPENSES	1000.

Fig. 4.15 (continued)

```
BEGINNING 12-31-69, THE VALUE OF THE NET INCOME
ON THE COMMON STOCK EQUITY COVERING A PLANNING PERIOD
OF  1 YEARS THROUGH 12-31-70 IS        944.


THE FOLLOWING RATIOS HAVE BEEN EXCEEDED BY THE PERCENTAGES INDICATED:
 RATIO(16) EXCEEDED BY    100%


THE FOLLOWING RATIOS SATISFY STANDARDS BY MORE THAN   75%:
 RATIO(11) SATISFIED BY  2700%
 RATIO(18) SATISFIED BY   710%
 RATIO( 2) SATISFIED BY   596%
 RATIO(17) SATISFIED BY   572%
 RATIO(27) SATISFIED BY   567%
 RATIO( 1) SATISFIED BY   530%
 RATIO(23) SATISFIED BY   132%
 RATIO(26) SATISFIED BY   129%
 RATIO(25) SATISFIED BY   109%
 RATIO(22) SATISFIED BY   103%
 RATIO(19) SATISFIED BY    92%
 RATIO( 9) SATISFIED BY    87%
 RATIO(12) SATISFIED BY    85%
 RATIO(24) SATISFIED BY    77%
```

Fig. 4.15. (continued)

SALES	5345.0000 TO	10690.0000	100%
COST OF GOODS SOLD	2060.0000 TO	4000.0000	94%
SELLING AND ADMINISTRATIVE EXPENSE	1114.0000 TO	2000.0000	80%

BEGINNING 12-31-69, THE VALUE OF THE NET INCOME
ON THE COMMON STOCK EQUITY COVERING A PLANNING HORIZON
OF 1 YEARS THROUGH 12-31-70 IS 2254.

THE FOLLOWING RATIOS HAVE BEEN EXCEEDED BY THE PERCENTAGES INDICATED:

RATIO(18) EXCEEDED BY	432%
RATIO(16) EXCEEDED BY	100%
RATIO(15) EXCEEDED BY	37%

Fig. 4.15. (continued)

PRODUCTION COST ON TRADE CREDIT	1200.0000 TO	2200.0000	83%
OTHER PRODUCTION EXPENSES	1000.0000 TO	2000.0000	100%
DIVIDENDS ON COMMON STOCK	142.0000 TO	260.0000	83%

THE FOLLOWING RATIOS HAVE BEEN EXCEEDED BY THE PERCENTAGES INDICATED:
RATIO(16) EXCEEDED BY 100%

PURCHASE(SALE) OF FIXED ASSETS	0.0000 TO	3600.0000	100%

THE FOLLOWING RATIOS HAVE BEEN EXCEEDED BY THE PERCENTAGES INDICATED:

RATIO(17) EXCEEDED BY	567%
RATIO(5) EXCEEDED BY	485%
RATIO(2) EXCEEDED BY	280%
RATIO(1) EXCEEDED BY	158%
RATIO(6) EXCEEDED BY	120%
RATIO(7) EXCEEDED BY	41%
RATIO(8) EXCEEDED BY	39%
RATIO(13) EXCEEDED BY	19%

Fig. 4.15. (continued)

PRO FORMA BALANCE SHEET AS OF 12-31-70 (AMOUNTS X 1000000.)

	$	CURR %	PREV %	CHG %	SALE %
CASH AND EQUIVALENTS	-2288.	-38	20	-286	-20
ACCOUNTS RECEIVABLE	1604.	27	27	0	15
INVENTORIES	390.	7	6	0	4
CURRENT ASSETS	-294.	-4	53	-108	-2
SECURITIES	14.	0	0	0	0
GROSS PLANT	7107.	120	58	103	66
DEPRECIATION	898.	15	12	25	8
NET PLANT	6209.	105	46	123	58
GROSS INTANGIBLE ASSETS	8.	0	0	0	0
AMORTIZATION	2.	0	0	0	0
NET INTANGIBLE ASSETS	6.	0	0	0	0
TOTAL ASSETS	5935.	100	100	-1	56
LOANS PAYABLE	33.	1	1	0	0
ACCOUNTS PAYABLE	220.	4	4	0	2
TAXES PAYABLE	0.	0	0	0	0
CURRENT LIABILITIES	253.	4	4	0	2
LONG TERM DEBT UNSUBORDINATED	0.	0	0	0	0
LONG TERM DEBT SUBORDINATED	459.	8	8	0	4
PREFERRED STOCK	0.	0	0	0	0
COMMON STOCK	272.	5	5	0	3
PAID IN SURPLUS	1039.	18	17	0	10
RETAINED EARNINGS	3912.	66	66	-1	37
TOTAL LIABILITIES AND NET WORTH	5935.	100	100	-1	56

Fig. 4.15. (continued)

```
LONGTERM DEBT UNSUBORD. PAYM. TO PRI        0.0000 TO    -3600.0000   100%

THE FOLLOWING RATIOS HAVE BEEN EXCEEDED BY THE PERCENTAGES INDICATED:
 RATIO(10) EXCEEDED BY     128%
 RATIO(13) EXCEEDED BY      21%


LONGTERM DEBT UNSUBORD. PAYM. TO PRI   -3600.0000 TO    -2600.0000   -27%

THE FOLLOWING RATIOS HAVE BEEN EXCEEDED BY THE PERCENTAGES INDICATED:
 RATIO(10) EXCEEDED BY      95%
 RATIO( 5) EXCEEDED BY      70%
 RATIO( 4) EXCEEDED BY      55%
 RATIO(13) EXCEEDED BY      20%


PURCHASE(SALE) OF FIXED ASSETS          3600.0000 TO     2600.0000   -27%

THE FOLLOWING RATIOS HAVE BEEN EXCEEDED BY THE PERCENTAGES INDICATED:
 RATIO(10) EXCEEDED BY      95%
 RATIO(13) EXCEEDED BY       1%
```

Fig. 4.15 (continued)

PRO FORMA SCHEDULE OF CHANGES IN WORKING CAPITAL
FOR THE YEAR ENDING 12-31-70 (AMOUNTS X 1000000.)

CHANGES IN CURRENT ASSETS	
CASH AND EQUIVALENTS	684.
ACCOUNTS RECEIVABLE	801.
INVENTORIES	200.
TOTAL	1684.

CHANGES IN CURRENT LIABILITIES	
LOANS PAYABLE	0.
ACCOUNTS PAYABLE	-313.
TAXES PAYABLE	-313.
TOTAL	-626.

WORKING CAPITAL CHANGE	2310.

Fig. 4.15 (continued)

PRO FORMA STATEMENT OF SOURCES AND USES OF FUNDS
FOR THE YEAR ENDING 12-31-70 (AMOUNTS X 1000000.)

SOURCES

NET INCOME	2129.
DEPRECIATION	440.
AMORTIZATION	2.
LONG TERM DEBT	2600.
TOTAL	5170.

USES

GROSS PLANT INCREASE	2600.
GROSS INTANGIBLE ASSET INCREASE	0.
DIVIDENDS ON PREFERRED STOCK	0.
DIVIDENDS ON COMMON STOCK	260.
WORKING CAPITAL INCREASE	2310.
TOTAL	5170.

Fig. 4.15. (continued)

PRO FORMA INCOME STATEMENT
FOR THE YEAR ENDING 12-31-70 (AMOUNTS X 1000000.)

	$	CURR %	PREV %	CHG %
SALES	10690.	100	100	0
COST OF GOODS SOLD	4000.	37	37	0
SELLING AND ADMINISTRATIVE EXPENSE	2000.	19	19	0
DEPRECIATION	440.	4	5	-9
AMORTIZATION	2.	0	0	0
NET OPERATING INCOME	4248.	40	39	1
NONOPERATING INCOME	0.	0	0	0
NONOPERATING EXPENSE	0.	0	0	0
INTEREST ON LOANS	155.	1	1	0
NET INCOME BEFORE TAXES	4094.	38	38	1
FEDERAL AND STATE INCOME TAXES	1965.	18	18	1
NET INCOME	2129.	20	20	1
DIVIDENDS ON PREFERRED STOCK	0.	0	0	0
NET INCOME ON COMMON STOCK	2129.	20	20	1
DIVIDENDS ON COMMON STOCK	260.	2	2	0
NET INCOME TO RETAINED EARNINGS	1869.	17	17	1

Fig. 4.15. (continued)

PRO FORMA BALANCE SHEET AS OF 12-31-70 (AMOUNTS X 1000000.)

	$	CURR %	PREV %	CHG %	SALE %
CASH AND EQUIVALENTS	1231.	14	3	383	12
ACCOUNTS RECEIVABLE	1604.	19	19	0	15
INVENTORIES	390.	5	5	0	4
CURRENT ASSETS	3224.	38	27	43	30
SECURITIES	14.	0	0	0	0
GROSS PLANT	6107.	72	84	-13	57
DEPRECIATION	848.	10	11	-5	8
NET PLANT	5259.	62	73	-14	49
GROSS INTANGIBLE ASSETS	8.	0	0	0	0
AMORTIZATION	2.	0	0	0	0
NET INTANGIBLE ASSETS	6.	0	0	0	0
TOTAL ASSETS	8504.	100	100	0	80
LOANS PAYABLE	33.	0	0	0	0
ACCOUNTS PAYABLE	220.	3	3	0	2
TAXES PAYABLE	0.	0	0	0	0
CURRENT LIABILITIES	253.	3	3	0	2
LONG TERM DEBT UNSUBORDINATED	2600.	31	31	0	24
LONG TERM DEBT SUBORDINATED	459.	5	5	0	4
PREFERRED STOCK	0.	0	0	0	0
COMMON STOCK	272.	3	3	0	3
PAID IN SURPLUS	1039.	12	12	0	10
RETAINED EARNINGS	3881.	46	45	1	36
TOTAL LIABILITIES AND NET WORTH	8504.	100	100	0	80

Fig. 4.15. (continued)

RATIO ANALYSIS FOR THE YEAR ENDING 12-31-70	ACTUAL		STANDARD
1 CURRENT RATIO	12.74	+>	2.00
2 QUICK RATIO	11.20	+>	1.50
3 INVENTORY TO WORKING CAPITAL	0.13	<	0.50
4 CASH TO CURRENT ASSETS	0.38	>	0.25
5 CASH TO TOTAL ASSETS	0.14	>	0.10
6 CURRENT ASSETS TO TOTAL ASSETS	0.38	>	0.25
7 GROSS PLANT TO TOTAL ASSETS	0.72	<	0.85
8 NET PLANT TO TOTAL ASSETS	0.62	<	0.75
9 CURRENT LIABILITIES TO TOTAL ASSETS	0.03	<	0.25
10 DEBT TO TOTAL ASSETS	0.39	*<	0.20
11 TIMES INTEREST EARNED	27.45	+>	1.50
12 CURRENT LIABILITIES TO NET WORTH	0.05	<	0.25
13 FIXED ASSETS TO NET WORTH	1.01	*<	1.00
14 DEPRECIATION TO GROSS PLANT	0.07	<	0.25
15 DIVIDEND PAYOUT RATIO	0.12	>	0.10
16 CAPITAL EXPENDITURE TO GROSS PLANT	0.74	+>	0.10
17 CASH VELOCITY	8.69	+>	1.00
18 INVENTORY TURNOVER	27.41	+>	2.00
19 FIXED ASSETS TURNOVER	2.03	+>	1.00
20 AVERAGE COLLECTION PERIOD	54.00	<	60.00
21 TOTAL ASSETS TURNOVER	1.26	>	1.00
22 GROSS OPERATING MARGIN	0.44	+>	0.20
23 NET OPERATING MARGIN	0.40	+>	0.15
24 SALES MARGIN	0.20	+>	0.10
25 PRODUCTIVITY OF ASSETS	0.27	+>	0.10
26 RETURN ON NET WORTH	0.41	+>	0.10
27 OPERATING INCOME TO NET PLANT	0.81	+>	0.10
28 OPERATING EXPENSE RATIO	0.56	<	0.70

Fig. 4.15. (continued)

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This study set out to examine the theoretical basis of man-machine systems. An attempt was made to examine the process of computer based decision making and apply it to the area of top management financial decision making.

It was shown that the dynamics of computer technology can directly affect man's information formation process and thus play a significant role in management decision making. However, difficulties may arise if the computer-problem interface cannot be established via an inter-disciplinary overlap. This difficulty can be overcome if the manager is placed directly in line with the computer and he is given the opportunity to use the computer without being hindered by the technical intricacies of the machine system. Subject to these requirements, a formalized man-machine system was defined which serves as the theoretical foundation for the implementation of a top management man-machine interactive decision making system. The effect of the application of the computer on the top management decision making process is significant because top level executives are more often able to:

1. make decisions at an early date,
2. gain time in which to consider some decisions,
3. consider more thorough analyses of some situations,

4. review several courses of action before deciding what to do, rather than have but one recommended course to consider,
5. examine analyses of the impact that recommended courses of action will have on the problem or opportunity identified, and
6. obtain additional detailed information from middle managers concerning problems, opportunities and promising alternatives before making decisions.

The feasibility of such a man-machine management control system is demonstrated in the form of the "Financial Interactive Planning Simulator," a top management financial decision making simulation system which was designed on a time sharing computer system and operates in the complementary mode. This simulator demonstrates that the computer can effectively complement the decision maker and, in turn, the decision maker can objectively complement the capabilities of the computer. This results in an effective and feasible system for the simulation of top management financial planning.

Specifically, it was demonstrated that a technique for financial management simulation can be developed which permits the top level manager to identify sensitive financial relationships. This is accomplished by posing "what if" questions and thereby interrogating the financial activity system. The feasibility of this simulation process was demonstrated by exploring a specific test case and verifying the system's responses as valid reactions to the specific input decisions.

The validity of utilizing a system of financial ratio constraints

was demonstrated by means of the mathematical derivation of the constraint system and was tested in Chapter IV by executing the simulator through a specific case.

This study demonstrated that a financial system simulator can be formulated and the dynamic nature of the simulation process can be maintained without resorting to the use of forecasting algorithms in the computer system. The use of the system demonstrates that the manager can control the planning process by formulating input decisions which constitute steps in the financial planning process. He is then able to modify his plans in response to the feedback obtained from the system and verify the consistency of all levels of financial activity.

Recommendations for Further Research

The financial interactive planning simulator supports the corporate financial planning process and serves as a tool for the investment analyst in evaluating the financial strength of a business organization. The simulator is capable of assisting in the planning process and forces the top level manager to establish planning objectives and quantify his planning variables. On the other hand, the user of the system has the opportunity for continued revisions of his plans, namely, his input decisions. This system lacks clearly defined organizational objectives. The objective function incorporated into the simulator is but a token attempt to aid the user of the system in engaging in a goal oriented simulation process. The interactive procedures implemented in the system permit the careless manager and decision maker to make random decisions and thus become trapped in a trial and error strategy of simulation. Therefore, it is imperative for the user of the system to have an under-

standing of financial activities and be capable of interpreting the results of the simulation.

Functional relationships incorporated into the simulator do not necessarily represent the complete process of financial data derivation. For example, no detailed production function is represented in the system. Rather, the user of the simulator specifies the level of production and therefore treats the production function exogenously in relationship to the system. A feasible extension of the model would be the incorporation of a detailed production function.

The most significant extension of the capabilities of the simulator can be achieved in incorporating the capabilities of the simultaneous simulation of all planning periods rather than one planning period at a time. In other words, the system could become a more powerful planning tool if the manager had the opportunity to change input decisions of any period other than the present period. The addition of this capability would make this simulator a more powerful long range planning tool besides offering the capability of simulating the financial decision making process sequentially in a time dependent fashion.

In conclusion, it must be pointed out, however, that the financial interactive planning simulator was designed for the purpose of giving the top management financial decision maker a simple but powerful tool for the purpose of testing the consequences of making a decision of the level of the financial activities of the firm and the resultant financial position of the enterprise.

APPENDIX

APPENDIX

The appendix contains the results of a two-year simulation of a firm and demonstrates the ability on the user's part to modify input decisions and test the results of such modifications.

Period 0

Initially, the manager specifies the limit to be imposed on the extent of the printout of financial ratios which meet the given standards by more than a specified percentage. In the present case, only those financial ratios will be identified in the sensitivity analysis which meet financial standards by one hundred percent or more. The basis for the simulation is the actual balance sheet as of the beginning of the first period to be simulated. Additional elements of the beginning process are the values of the exogenous variables and the initial input decisions. These values are printed at this time to offer the decision maker the opportunity to scrutinize these values and change them at the beginning of the simulation cycle if he so desires.

FINANCIAL INTERACTIVE PLANNING SIMULATOR
WHAT SENSITIVITY RANGE DO YOU DESIRE
?1.

DO YOU WISH TO PRINT THE BALANCE SHEET FOR BASE PERIOD
?YES

BALANCE SHEET AS OF 12-31-69 (AMOUNTS X 1000000.)

	$	CURR %	PREV %	CHG %	SALE %
CASH AND EQUIVALENTS	547.	12	12	0	10
ACCOUNTS RECEIVABLE	803.	17	17	0	15
INVENTORIES	190.	4	4	0	4
CURRENT ASSETS	1540.	33	33	0	29
SECURITIES	14.	0	0	0	0
GROSS PLANT	3507.	75	75	0	66
DEPRECIATION	408.	9	9	0	8
NET PLANT	3099.	66	66	0	58
GROSS INTANGIBLE ASSETS	8.	0	0	0	0
AMORTIZATION	0.	0	0	0	0
NET INTANGIBLE ASSETS	8.	0	0	0	0
TOTAL ASSETS	4661.	100	100	0	87
LOANS PAYABLE	33.	1	1	0	1
ACCOUNTS PAYABLE	533.	11	11	0	10
TAXES PAYABLE	313.	7	7	0	6
CURRENT LIABILITIES	879.	19	19	0	16
LONG TERM DEBT UNSUBORDINATED	0.	0	0	0	0
LONG TERM DEBT SUBORDINATED	459.	10	10	0	9
PREFERRED STOCK	0.	0	0	0	0
COMMON STOCK	272.	6	6	0	5
PAID IN SURPLUS	1039.	22	22	0	19
RETAINED EARNINGS	2012.	43	43	0	38
TOTAL LIABILITIES AND NET WORTH	4661.	100	100	0	87

DO YOU WISH TO PRINT EXOG. VARIABLES
?YES

EXOG. VARIABLES FOR THE YEAR ENDING 12-31-69 (AMOUNTS X 1000000.)

RATE OF INTEREST EARNED ON SECURITIES	0.0700
RATE OF DEPRECIATION	0.1000
SCALE FACTOR FOR DOLLAR AMOUNTS	1000000.0000
RATE OF AMORTIZATION	0.2000
RATE OF INTEREST ON LOANS	0.0900
INTEREST RATE LONGTERM DEBT UNSUBORD.	0.0850
INTEREST RATE LONGTERM DEBT SUBORD.	0.0900
RATE OF PAYMENT ON ACCOUNTS PAYABLE	0.9000
RATE OF RECEIPT ON ACCOUNTS RECEIVABLE	0.8000
RATE OF PAYMENT ON TAXES PAYABLE	1.0000
PAR VALUE OF COMMON STOCK	5.0000
NO. OF SHARES OF COMMON OUTSTANDING	54.4482
NO. OF SHARES OF PREFERRED OUTSTANDING	0.0000
BASE YEAR	69.0000

DO YOU WISH TO PRINT INPUT DECISIONS
?YES

INPUT DECISIONS FOR THE YEAR ENDING 12-31-69 (AMOUNTS X 1000000.)

SALES	5345.
COST OF GOODS SOLD	2060.
SELLING AND ADMINISTRATIVE EXPENSE	1114.
NONOPERATING EXPENSE	0.
DIVIDENDS ON PREFERRED STOCK	0.
DIVIDENDS ON COMMON STOCK	0.
PURCHASES(SALE) OF SECURITIES	0.
PURCHASE(SALE) OF FIXED ASSETS	0.
NONOPERATING INCOME OTHER THAN INTEREST	0.
SHORT TERM LOAN PAYMENT ON PRINCIPAL	0.
LONGTERM DEBT UNSUBORD. PAYM. TO PRINC.	0.
LONGTERM DEBT SUBORD. PAYM. TO PRINC.	0.
ACQUISITION(SALE) OF INTANGIBLE ASSETS	0.
NO. OF ADD. SHARES OF PREF. STOCK	0.
PRICE/SHARE OF PREFERRED STOCK	0.
NO. OF ADD. SHARES OF COMMON STOCK	0.
PRICE/SHARE OF COMMON STOCK	0.
PRODUCTION COST ON TRADE CREDIT	1200.
OTHER PRODUCTION EXPENSES	2000.

Period 1 - Cycle 1

At the beginning of the simulation cycle the user is given the opportunity to change any one of the following variables: exogenous variables, financial ratio standards, and variables identified in the input decision printout. No change of variable is desired for the first simulation cycle and, therefore, the first simulation is executed with the values which were printed out during the initial phase. Based on the results of the sensitivity analysis, the following actions appear to be necessary:

1. Inventory levels are too high and should be reduced.
2. The cash level must be increased.
3. According to the financial ratio standard, common stock dividends should be paid.
4. The collection period is too high according to the standard specified and should be reduced.
5. The planned level for capital expenditures has not been met; hence, plans should be made for capital expenditures.

The above observations are then supported by the working capital analysis, the statement of sources and uses of funds, the income statement, the balance sheet and the ratio analysis for the first simulated time period.

DO YOU WISH TO CHANGE A VARIABLE
?NO

BEGINNING 12-31-69, THE VALUE OF THE NET INCOME
ON THE COMMON STOCK EQUITY COVERING A PLANNING PERIOD
OF 1 YEARS THROUGH 12-31-70 IS 944.

THE FOLLOWING RATIOS HAVE BEEN EXCEEDED BY THE PERCENTAGES INDICATED:

RATIO(17)	EXCEEDED BY	1722%
RATIO(5)	EXCEEDED BY	168%
RATIO(4)	EXCEEDED BY	164%
RATIO(16)	EXCEEDED BY	100%
RATIO(15)	EXCEEDED BY	100%
RATIO(3)	EXCEEDED BY	39%
RATIO(20)	EXCEEDED BY	20%

```
THE FOLLOWING RATIOS SATISFY STANDARDS BY MORE THAN  100%:
 RATIO(11) SATISFIED BY  2700%
 RATIO( 1) SATISFIED BY   576%
 RATIO(27) SATISFIED BY   567%
 RATIO( 2) SATISFIED BY   222%
 RATIO(23) SATISFIED BY   132%
 RATIO(26) SATISFIED BY   121%
 RATIO(22) SATISFIED BY   103%
 RATIO(25) SATISFIED BY   103%
 RATIO(18) SATISFIED BY   101%



THE FOLLOWING VARIABLES CAUSE SENSITIVITY:
SALES
     INCR: 17 20
     DECR: 11 15 18 22 23 25 26 27
COST OF GOODS SOLD
     INCR: 11 15 22 23 25 26 27
SELLING AND ADMINISTRATIVE EXPENSE
     INCR: 11 15 22 23 25 26 27
DEPRECIATION
     INCR: 11 15 23 25 26 27
AMORTIZATION
     INCR: 11 15 23 25 26 27
NONOPERATING INCOME
     DECR: 11 15 23 26
NONOPERATING EXPENSE
     INCR: 11 15 23 26
INTEREST ON LOANS
     INCR: 11 15 23 26
FEDERAL AND STATE INCOME TAXES
     INCR: 15 25 26
DIVIDENDS ON PREFERRED STOCK
     INCR: 15 26
DIVIDENDS ON COMMON STOCK
     INCR: 15
```

```
CASH AND EQUIVALENTS
     INCR:  3  4  5 25
     DECR:  1  2 17
ACCOUNTS RECEIVABLE
     INCR:  3 25
     DECR:  1  2  4  5 20
INVENTORIES
     INCR: 18 25
     DECR:  1  3  4  5
SECURITIES
     INCR: 25
     DECR:  5
GROSS PLANT
     INCR: 16 25 27
     DECR:  5
DEPRECIATION
     INCR:  5
     DECR: 25 27
GROSS INTANGIBLE ASSETS
     INCR: 25
     DECR:  5
AMORTIZATION
     INCR:  5
     DECR: 25
LOANS PAYABLE
     INCR:  1  2
     DECR:  3
ACCOUNTS PAYABLE
     INCR:  1  2
     DECR:  3
TAXES PAYABLE
     INCR:  1  2
     DECR:  3
COMMON STOCK
     INCR: 26
PAID IN SURPLUS
     INCR: 26
RETAINED EARNINGS
     INCR: 26
```

DO YOU WISH TO PRINT THE WORKING CAPITAL ANALYSIS
?YES

PRO FORMA SCHEDULE OF CHANGES IN WORKING CAPITAL
FOR THE YEAR ENDING 12-31-70 (AMOUNTS X 1000000.)

CHANGES IN CURRENT ASSETS

CASH AND EQUIVALENTS	-877.
ACCOUNTS RECEIVABLE	266.
INVENTORIES	1140.
TOTAL	529.

CHANGES IN CURRENT LIABILITIES

LOANS PAYABLE	0.
ACCOUNTS PAYABLE	-413.
TAXES PAYABLE	-313.
TOTAL	-726.

WORKING CAPITAL CHANGE	1255.

PRO FORMA STATEMENT OF SOURCES AND USES OF FUNDS
FOR THE YEAR ENDING 12-31-70 (AMOUNTS X 1000000.)

SOURCES

NET INCOME	944.
DEPRECIATION	310.
AMORTIZATION	2.
LONG TERM DEBT	0.
TOTAL	1255.

USES

GROSS PLANT INCREASE	0.
GROSS INTANGIBLE ASSET INCREASE	0.
DIVIDENDS ON PREFERRED STOCK	0.
DIVIDENDS ON COMMON STOCK	0.
WORKING CAPITAL INCREASE	1255.
TOTAL	1255.

DO YOU WISH TO PRINT THE INCOME STATEMENT
?YES

PRO FORMA INCOME STATEMENT
FOR THE YEAR ENDING 12-31-70 (AMOUNTS X 1000000.)

	$	CURR %	PREV %	CHG %
SALES	5345.	100	100	0
COST OF GOODS SOLD	2060.	39	39	0
SELLING AND ADMINISTRATIVE EXPENSE	1114.	21	21	0
DEPRECIATION	310.	6	6	0
AMORTIZATION	2.	0	0	0
NET OPERATING INCOME	1859.	35	35	0
NONOPERATING INCOME	0.	0	0	0
NONOPERATING EXPENSE	0.	0	0	0
INTEREST ON LOANS	44.	1	1	0
NET INCOME BEFORE TAXES	1815.	34	34	0
FEDERAL AND STATE INCOME TAXES	871.	16	16	0
NET INCOME	944.	18	18	0
DIVIDENDS ON PREFERRED STOCK	0.	0	0	0
NET INCOME ON COMMON STOCK	944.	18	18	0
DIVIDENDS ON COMMON STOCK	0.	0	0	0
NET INCOME TO RETAINED EARNINGS	944.	18	18	0

DO YOU WISH TO PRINT THE BALANCE SHEET
?YES

PRO FORMA BALANCE SHEET AS OF 12-31-70 (AMOUNTS X 1000000.)

	$	CURR %	PREV %	CHG %	SALE %
CASH AND EQUIVALENTS	-330.	-6	12	-159	-5
ACCOUNTS RECEIVABLE	1069.	22	17	33	20
INVENTORIES	1330.	27	4	600	25
CURRENT ASSETS	2069.	42	33	34	39
SECURITIES	14.	0	0	0	0
GROSS PLANT	3507.	72	75	0	66
DEPRECIATION	718.	15	9	76	13
NET PLANT	2789.	57	66	-9	52
GROSS INTANGIBLE ASSETS	8.	0	0	0	0
AMORTIZATION	2.	0	0	0	0
NET INTANGIBLE ASSETS	6.	0	0	-19	0
TOTAL ASSETS	4879.	100	100	5	91
LOANS PAYABLE	33.	1	1	0	1
ACCOUNTS PAYABLE	120.	2	11	-76	2
TAXES PAYABLE	0.	0	7	-99	0
CURRENT LIABILITIES	153.	3	19	-82	3
LONG TERM DEBT UNSUBORDINATED	0.	0	0	0	0
LONG TERM DEBT SUBORDINATED	459.	9	10	0	9
PREFERRED STOCK	0.	0	0	0	0
COMMON STOCK	272.	6	6	0	5
PAID IN SURPLUS	1039.	21	22	0	19
RETAINED EARNINGS	2956.	61	43	47	55
TOTAL LIABILITIES AND NET WORTH	4879.	100	100	5	91

DO YOU WISH TO PRINT THE RATIO ANALYSIS
?YES

RATIO ANALYSIS FOR THE YEAR ENDING 12-31-70

		ACTUAL		STANDARD
1	CURRENT RATIO	13.53	+>	2.00
2	QUICK RATIO	4.83	+>	1.50
3	INVENTORY TO WORKING CAPITAL	0.69	*<	0.50
4	CASH TO CURRENT ASSETS	-.16	*>	0.25
5	CASH TO TOTAL ASSETS	-.07	*>	0.10
6	CURRENT ASSETS TO TOTAL ASSETS	0.42	>	0.25
7	GROSS PLANT TO TOTAL ASSETS	0.72	<	0.80
8	NET PLANT TO TOTAL ASSETS	0.57	<	0.75
9	CURRENT LIABILITIES TO TOTAL ASSETS	0.03	<	0.25
10	DEBT TO TOTAL ASSETS	0.13	<	0.20
11	TIMES INTEREST EARNED	41.99	+>	1.50
12	CURRENT LIABILITIES TO NET WORTH	0.04	<	0.25
13	FIXED ASSETS TO NET WORTH	0.65	<	1.00
14	DEPRECIATION TO GROSS PLANT	0.09	<	0.25
15	DIVIDEND PAYOUT RATIO	0.00	*>	0.10
16	CAPITAL EXPENDITURE TO GROSS PLANT	0.00	*>	0.10
17	CASH VELOCITY	-16.22	*>	1.00
18	INVENTORY TURNOVER	4.02	+>	2.00
19	FIXED ASSETS TURNOVER	1.92	>	1.00
20	AVERAGE COLLECTION PERIOD	72.00	*<	60.00
21	TOTAL ASSETS TURNOVER	1.10	>	1.00
22	GROSS OPERATING MARGIN	0.41	+>	0.20
23	NET OPERATING MARGIN	0.35	+>	0.15
24	SALES MARGIN	0.18	>	0.10
25	PRODUCTIVITY OF ASSETS	0.20	+>	0.10
26	RETURN ON NET WORTH	0.22	+>	0.10
27	OPERATING INCOME TO NET PLANT	0.67	+>	0.10
28	OPERATING EXPENSE RATIO	0.59	<	0.70

Period 1 - Cycle 2

The decision is now made to repeat the simulation for the present period. Repeating this planning cycle allows the decision maker to change values for various variables. In order to decrease the collection period, the decision is made to increase the rate of receipt on accounts receivable from .8 to .85. In other words, it is desired to reduce the average collection period to fifty-four days. The level of payment of common stock dividends is set at fifteen percent of the net income earned on the common stock. Then a capital expenditure is earmarked. In order to reduce inventory levels, the decision is made to decrease cash production expenses by fifty percent. This will also help improve the cash position of the firm. The four decisions should significantly aid in meeting the five shortcomings identified during Cycle 1 of the simulation process. The sensitivity analysis still identifies two ratios which are not within the financial constraints imposed upon the firm. However, upon examination of the financial statements and because of the fact that the discrepancies are not extensive, the decision is made to accept the results of this simulation cycle and proceed to the next time period.

```
DO YOU WISH TO CHANGE PRESENT PERIOD RESULTS
?YES

DO YOU WISH TO CHANGE A VARIABLE
?YES

TO IDENTIFY TYPE OF VARIABLE OR END OF CHANGE TYPE:
   NONE, EXOG, RATI, INCO, OR OTHE

VARIABLE TYPE
?EXOG

VARIABLE NO.
?9

VALUE
?.85

RATE OF RECEIPT ON ACCOUNTS RECEIVAB      0.8000 TO       0.8500    6%


VARIABLE TYPE
?INCO

VARIABLE NO.
?15

VALUE
?141.6

DIVIDENDS ON COMMON STOCK                 0.0000 TO     141.6000  100%
```

VARIABLE TYPE
?OTHE

VARIABLE NO.
?4

VALUE
?400.

PURCHASE(SALE) OF FIXED ASSETS 0.0000 TO 400.0000 100%

VARIABLE TYPE
?OTHE

VARIABLE NO.
?17

VALUE
?1000.

OTHER PRODUCTION EXPENSES 2000.0000 TO 1000.0000 -49%

VARIABLE TYPE
?NONE

DO YOU WISH TO PRINT EXOG. VARIABLES
?NO

DO YOU WISH TO PRINT INPUT DECISIONS
?NO

BEGINNING 12-31-69, THE VALUE OF THE NET INCOME
ON THE COMMON STOCK EQUITY COVERING A PLANNING PERIOD
OF 1 YEARS THROUGH 12-31-70 IS   934.

THE FOLLOWING RATIOS HAVE BEEN EXCEEDED BY THE PERCENTAGES INDICATED:
 RATIO(5) EXCEEDED BY   14%
 RATIO(7) EXCEEDED BY   3%

THE FOLLOWING RATIOS SATISFY STANDARDS BY MORE THAN 100%:
 RATIO(11) SATISFIED BY 2669%
 RATIO(17) SATISFIED BY 1218%
 RATIO(18) SATISFIED BY   710%
 RATIO(27) SATISFIED BY   480%
 RATIO(2) SATISFIED BY   426%
 RATIO(1) SATISFIED BY   402%
 RATIO(23) SATISFIED BY   129%
 RATIO(26) SATISFIED BY   127%
 RATIO(25) SATISFIED BY   107%
 RATIO(22) SATISFIED BY   103%

THE FOLLOWING VARIABLES CAUSE SENSITIVITY:
SALES
     DECR: 11 17 18 22 23 25 26 27
COST OF GOODS SOLD
     INCR: 11 22 23 25 26 27
SELLING AND ADMINISTRATIVE EXPENSE
     INCR: 11 22 23 25 26 27
DEPRECIATION
     INCR: 11 23 25 26 27
AMORTIZATION
     INCR: 11 23 25 26 27
NONOPERATING INCOME
     DECR: 11 23 26
NONOPERATING EXPENSE
     INCR: 11 23 26

```
INTEREST ON LOANS
     INCR: 11 23 26
FEDERAL AND STATE INCOME TAXES
     INCR: 25 26
DIVIDENDS ON PREFERRED STOCK
     INCR: 26
CASH AND EQUIVALENTS
     INCR:  5  7 17 25
     DECR:  1  2
ACCOUNTS RECEIVABLE
     INCR:  7 25
     DECR:  1  2  5
INVENTORIES
     INCR:  7 18 25
     DECR:  1  5
SECURITIES
     INCR:  7 25
     DECR:  5
GROSS PLANT
     INCR: 25 27
     DECR:  5  7
DEPRECIATION
     INCR:  5
     DECR:  7 25 27
GROSS INTANGIBLE ASSETS
     INCR:  7 25
     DECR:  5
AMORTIZATION
     INCR:  5
     DECR:  7 25
LOANS PAYABLE
     INCR:  1  2
ACCOUNTS PAYABLE
     INCR:  1  2
TAXES PAYABLE
     INCR:  1  2
COMMON STOCK
     INCR: 26
PAID IN SURPLUS
     INCR: 26
RETAINED EARNINGS
     INCR: 26
```

DO YOU WISH TO PRINT THE WORKING CAPITAL ANALYSIS
?YES

PRO FORMA SCHEDULE OF CHANGES IN WORKING CAPITAL
FOR THE YEAR ENDING 12-31-70 (AMOUNTS X 1000000.)

CHANGES IN CURRENT ASSETS

CASH AND EQUIVALENTS	-141.
ACCOUNTS RECEIVABLE	-1.
INVENTORIES	140.
TOTAL	-3.

CHANGES IN CURRENT LIABILITIES

LOANS PAYABLE	0.
ACCOUNTS PAYABLE	-413.
TAXES PAYABLE	-313.
TOTAL	-726.

WORKING CAPITAL CHANGE	723.

PRO FORMA STATEMENT OF SOURCES AND USES OF FUNDS
FOR THE YEAR ENDING 12-31-70 (AMOUNTS X 1000000.)

SOURCES

NET INCOME	934.
DEPRECIATION	330.
AMORTIZATION	2.
LONG TERM DEBT	0.
TOTAL	1265.

USES

GROSS PLANT INCREASE	400.
GROSS INTANGIBLE ASSET INCREASE	0.
DIVIDENDS ON PREFERRED STOCK	0.
DIVIDENDS ON COMMON STOCK	142.
WORKING CAPITAL INCREASE	723.
TOTAL	1265.

DO YOU WISH TO PRINT THE INCOME STATEMENT
?YES

PRO FORMA INCOME STATEMENT
FOR THE YEAR ENDING 12-31-70 (AMOUNTS X 1000000.)

	$	CURR %	PREV %	CHG %
SALES	5345.	100	100	0
COST OF GOODS SOLD	2060.	39	39	0
SELLING AND ADMINISTRATIVE EXPENSE	1114.	21	21	0
DEPRECIATION	330.	6	6	6
AMORTIZATION	2.	0	0	0
NET OPERATING INCOME	1839.	34	35	0
NONOPERATING INCOME	0.	0	0	0
NONOPERATING EXPENSE	0.	0	0	0
INTEREST ON LOANS	44.	1	1	0
NET INCOME BEFORE TAXES	1795.	34	34	0
FEDERAL AND STATE INCOME TAXES	862.	16	16	0
NET INCOME	934.	17	18	0
DIVIDENDS ON PREFERRED STOCK	0.	0	0	0
NET INCOME ON COMMON STOCK	934.	17	18	0
DIVIDENDS ON COMMON STOCK	142.	3	0	0
NET INCOME TO RETAINED EARNINGS	792.	15	18	-15

DO YOU WISH TO PRINT THE BALANCE SHEET
?YES

PRO FORMA BALANCE SHEET AS OF 12-31-70 (AMOUNTS X 1000000.)

	$	CURR %	PREV %	CHG %	SALE %
CASH AND EQUIVALENTS	406.	9	-6	-222	8
ACCOUNTS RECEIVABLE	802.	17	22	-24	15
INVENTORIES	330.	7	27	-74	6
CURRENT ASSETS	1537.	33	42	-25	29
SECURITIES	14.	0	0	0	0
GROSS PLANT	3907.	83	72	11	73
DEPRECIATION	738.	16	15	3	14
NET PLANT	3169.	67	57	14	59
GROSS INTANGIBLE ASSETS	8.	0	0	0	0
AMORTIZATION	2.	0	0	0	0
NET INTANGIBLE ASSETS	6.	0	0	0	0
TOTAL ASSETS	4727.	100	100	-2	88
LOANS PAYABLE	33.	1	1	0	1
ACCOUNTS PAYABLE	120.	3	2	0	2
TAXES PAYABLE	0.	0	0	-99	0
CURRENT LIABILITIES	153.	3	3	0	3
LONG TERM DEBT UNSUBORDINATED	0.	0	0	0	0
LONG TERM DEBT SUBORDINATED	459.	10	9	0	9
PREFERRED STOCK	0.	0	0	0	0
COMMON STOCK	272.	6	6	0	5
PAID IN SURPLUS	1039.	22	21	0	19
RETAINED EARNINGS	2804.	59	61	-4	52
TOTAL LIABILITIES AND NET WORTH	4727.	100	100	-2	88

DO YOU WISH TO PRINT THE RATIO ANALYSIS
?YES

	RATIO ANALYSIS FOR THE YEAR ENDING 12-31-70	ACTUAL		STANDARD
1	CURRENT RATIO	10.05	+>	2.00
2	QUICK RATIO	7.89	+>	1.50
3	INVENTORY TO WORKING CAPITAL	0.24	<	0.50
4	CASH TO CURRENT ASSETS	0.26	>	0.25
5	CASH TO TOTAL ASSETS	0.09	*>	0.10
6	CURRENT ASSETS TO TOTAL ASSETS	0.33	>	0.25
7	GROSS PLANT TO TOTAL ASSETS	0.83	*<	0.80
8	NET PLANT TO TOTAL ASSETS	0.67	<	0.75
9	CURRENT LIABILITIES TO TOTAL ASSETS	0.03	<	0.25
10	DEBT TO TOTAL ASSETS	0.10	<	0.20
11	TIMES INTEREST EARNED	41.54	+>	1.50
12	CURRENT LIABILITIES TO NET WORTH	0.04	<	0.25
13	FIXED ASSETS TO NET WORTH	0.77	<	1.00
14	DEPRECIATION TO GROSS PLANT	0.08	<	0.25
15	DIVIDEND PAYOUT RATIO	0.15	>	0.10
16	CAPITAL EXPENDITURE TO GROSS PLANT	0.11	>	0.10
17	CASH VELOCITY	13.18	+>	1.00
18	INVENTORY TURNOVER	16.20	+>	2.00
19	FIXED ASSETS TURNOVER	1.69	>	1.00
20	AVERAGE COLLECTION PERIOD	54.00	<	60.00
21	TOTAL ASSETS TURNOVER	1.13	>	1.00
22	GROSS OPERATING MARGIN	0.41	+>	0.20
23	NET OPERATING MARGIN	0.34	+>	0.15
24	SALES MARGIN	0.17	>	0.10
25	PRODUCTIVITY OF ASSETS	0.21	+>	0.10
26	RETURN ON NET WORTH	0.23	+>	0.10
27	OPERATING INCOME TO NET PLANT	0.58	+>	0.10
28	OPERATING EXPENSE RATIO	0.59	<	0.70

Period 2 - Cycle 1

Before commencing with the execution of the next simulation cycle, several variable values will be changed. First, it is noted that in the past all taxes were paid by the end of the period. By changing the rate of payment on taxes payable from 1.0 to 0.75, taxes payable for the last quarter will appear in the taxes payable account on the balance sheet and will not be paid until the first quarter of the next year. Because of the high level of investment in fixed assets of the firm in relationship to total assets, the decision is made to raise the financial ratio standard of the gross plant to total assets ratio from 0.8 to 0.95. During this time period, a capital expenditure of nine hundred million dollars is contemplated. The last input decision reflects the desire to obtain a five hundred million dollar unsubordinated long-term loan. The subsequent simulation points out that a weakness seems to appear in the total assets turnover. Either sales have not increased sufficiently, or the total assets have increased too rapidly in relationship to the gross sales during the present time period. Of course, another factor in the sensitivity of the total assets turnover ratio could be the decision on the level of the financial ratio standard.

```
DO YOU WISH TO CHANGE PRESENT PERIOD RESULTS
?NO

DO YOU WISH TO QUIT
?NO

DO YOU WISH TO CHANGE A VARIABLE
?YES

TO IDENTIFY TYPE OF VARIABLE OR END OF CHANGE TYPE:
   NONE, EXOG, RATI, INCO, OR OTHE

VARIABLE TYPE
?EXOG

VARIABLE NO.
?10

VALUE
?.75

RATE OF PAYMENT ON TAXES PAYABLE          1.0000 TO        0.7500  -24%

VARIABLE TYPE
?RATI

VARIABLE NO.
?7

VALUE
?.95
```

```
<GROSS PLANT TO TOTAL ASSETS                0.8000 TO        0.9500   19%

VARIABLE TYPE
?OTHE

VARIABLE NO.
?4

VALUE
?900.

PURCHASE(SALE) OF FIXED ASSETS            400.0000 TO      900.0000  125%

VARIABLE TYPE
?OTHE

VARIABLE NO.
?9

VALUE
?-500.

LONGTERM DEBT UNSUBORD. PAYM. TO PRI        0.0000 TO     -500.0000  100%

VARIABLE TYPE
?NONE

DO YOU WISH TO PRINT EXOG. VARIABLES
?NO
```

DO YOU WISH TO PRINT INPUT DECISIONS
?YES

INPUT DECISIONS FOR THE YEAR ENDING 12-31-71 (AMOUNTS X 1000000.)

SALES	5345.
COST OF GOODS SOLD	2060.
SELLING AND ADMINISTRATIVE EXPENSE	1114.
NONOPERATING EXPENSE	0.
DIVIDENDS ON PREFERRED STOCK	0.
DIVIDENDS ON COMMON STOCK	142.
PURCHASES(SALE) OF SECURITIES	0.
PURCHASE(SALE) OF FIXED ASSETS	900.
NONOPERATING INCOME OTHER THAN INTEREST	0.
SHORT TERM LOAN PAYMENT ON PRINCIPAL	0.
LONGTERM DEBT UNSUBORD. PAYM. TO PRINC.	-500.
LONGTERM DEBT SUBORD. PAYM. TO PRINC.	0.
ACQUISITION(SALE) OF INTANGIBLE ASSETS	0.
NO. OF ADD. SHARES OF PREF. STOCK	0.
PRICE/SHARE OF PREFERRED STOCK	0.
NO. OF ADD. SHARES OF COMMON STOCK	0.
PRICE/SHARE OF COMMON STOCK	0.
PRODUCTION COST ON TRADE CREDIT	1200.
OTHER PRODUCTION EXPENSES	1000.

BEGINNING 12-31-69, THE VALUE OF THE NET INCOME
ON THE COMMON STOCK EQUITY COVERING A PLANNING PERIOD
OF 2 YEARS THROUGH 12-31-71 IS 1933.

THE FOLLOWING RATIOS HAVE BEEN EXCEEDED BY THE PERCENTAGES INDICATED:
RATIO(21) EXCEEDED BY 14%
RATIO(10) EXCEEDED BY 7%

THE FOLLOWING RATIOS SATISFY STANDARDS BY MORE THAN 100%:
RATIO(11) SATISFIED BY 1739%
RATIO(18) SATISFIED BY 469%
RATIO(27) SATISFIED BY 388%
RATIO(17) SATISFIED BY 345%
RATIO(2) SATISFIED BY 269%
RATIO(1) SATISFIED BY 242%
RATIO(16) SATISFIED BY 130%
RATIO(23) SATISFIED BY 125%
RATIO(22) SATISFIED BY 103%

THE FOLLOWING VARIABLES CAUSE SENSITIVITY:
SALES
INCR: 21
DECR: 11 17 18 22 23 27
COST OF GOODS SOLD
INCR: 11 22 23 27
SELLING AND ADMINISTRATIVE EXPENSE
INCR: 11 22 23 27
DEPRECIATION
INCR: 11 23 27
AMORTIZATION
INCR: 11 23 27
NONOPERATING INCOME
DECR: 11 23
NONOPERATING EXPENSE
INCR: 11 23
INTEREST ON LOANS
INCR: 11 23

```
CASH AND EQUIVALENTS
     INCR: 10 17
     DECR:  1  2 21
ACCOUNTS RECEIVABLE
     INCR: 10
     DECR:  1  2 21
INVENTORIES
     INCR: 10 18
     DECR:  1 21
SECURITIES
     INCR: 10
     DECR: 21
GROSS PLANT
     INCR: 10 27
     DECR: 16 21
DEPRECIATION
     INCR: 21
     DECR: 10 27
GROSS INTANGIBLE ASSETS
     INCR: 10
     DECR: 21
AMORTIZATION
     INCR: 21
     DECR: 10
LOANS PAYABLE
     INCR:  1  2
     DECR: 10
ACCOUNTS PAYABLE
     INCR:  1  2
TAXES PAYABLE
     INCR:  1  2
LONG TERM DEBT UNSUBORDINATED
     DECR: 10
LONG TERM DEBT SUBORDINATED
     DECR: 10
```

DO YOU WISH TO PRINT THE WORKING CAPITAL ANALYSIS
?YES

PRO FORMA SCHEDULE OF CHANGES IN WORKING CAPITAL
FOR THE YEAR ENDING 12-31-71 (AMOUNTS X 1000000.)

CHANGES IN CURRENT ASSETS

CASH AND EQUIVALENTS	797.
ACCOUNTS RECEIVABLE	0.
INVENTORIES	140.
TOTAL	937.

CHANGES IN CURRENT LIABILITIES

LOANS PAYABLE	0.
ACCOUNTS PAYABLE	0.
TAXES PAYABLE	209.
TOTAL	209.

WORKING CAPITAL CHANGE	728.

PRO FORMA STATEMENT OF SOURCES AND USES OF FUNDS
FOR THE YEAR ENDING 12-31-71 (AMOUNTS X 1000000.)

SOURCES

NET INCOME	906.
DEPRECIATION	362.
AMORTIZATION	1.
LONG TERM DEBT	500.
TOTAL	1769.

USES

GROSS PLANT INCREASE	900.
GROSS INTANGIBLE ASSET INCREASE	0.
DIVIDENDS ON PREFERRED STOCK	0.
DIVIDENDS ON COMMON STOCK	142.
WORKING CAPITAL INCREASE	728.
TOTAL	1769.

DO YOU WISH TO PRINT THE INCOME STATEMENT
?YES

PRO FORMA INCOME STATEMENT
FOR THE YEAR ENDING 12-31-71 (AMOUNTS X 1000000.)

	$	CURR %	PREV %	CHG %
SALES	5345.	100	100	0
COST OF GOODS SOLD	2060.	39	39	0
SELLING AND ADMINISTRATIVE EXPENSE	1114.	21	21	0
DEPRECIATION	362.	7	6	10
AMORTIZATION	1.	0	0	-19
NET OPERATING INCOME	1808.	34	34	-1
NONOPERATING INCOME	0.	0	0	0
NONOPERATING EXPENSE	0.	0	0	0
INTEREST ON LOANS	66.	1	1	48
NET INCOME BEFORE TAXES	1742.	33	34	-2
FEDERAL AND STATE INCOME TAXES	836.	16	16	-2
NET INCOME	906.	17	17	-2
DIVIDENDS ON PREFERRED STOCK	0.	0	0	0
NET INCOME ON COMMON STOCK	906.	17	17	-2
DIVIDENDS ON COMMON STOCK	142.	3	3	0
NET INCOME TO RETAINED EARNINGS	764.	14	15	-2

DO YOU WISH TO PRINT THE BALANCE SHEET
?YES

PRO FORMA BALANCE SHEET AS OF 12-31-71 (AMOUNTS X 1000000.)

	$	CURR %	PREV %	CHG %	SALE %
CASH AND EQUIVALENTS	1202.	19	9	196	22
ACCOUNTS RECEIVABLE	802.	13	17	0	15
INVENTORIES	470.	8	7	42	9
CURRENT ASSETS	2474.	40	33	61	46
SECURITIES	14.	0	0	0	0
GROSS PLANT	4807.	78	83	23	90
DEPRECIATION	1100.	18	16	49	21
NET PLANT	3707.	60	67	17	69
GROSS INTANGIBLE ASSETS	8.	0	0	0	0
AMORTIZATION	3.	0	0	80	0
NET INTANGIBLE ASSETS	5.	0	0	-19	0
TOTAL ASSETS	6200.	100	100	31	116
LOANS PAYABLE	33.	1	1	0	1
ACCOUNTS PAYABLE	120.	2	3	0	2
TAXES PAYABLE	209.	3	0	0	4
CURRENT LIABILITIES	362.	6	3	137	7
LONG TERM DEBT UNSUBORDINATED	500.	8	0	0	9
LONG TERM DEBT SUBORDINATED	459.	7	10	0	9
PREFERRED STOCK	0.	0	0	0	0
COMMON STOCK	272.	4	6	0	5
PAID IN SURPLUS	1039.	17	22	0	19
RETAINED EARNINGS	3568.	58	59	27	67
TOTAL LIABILITIES AND NET WORTH	6200.	100	100	31	116

DO YOU WISH TO PRINT THE RATIO ANALYSIS
?YES

RATIO ANALYSIS FOR THE YEAR ENDING 12-31-71

		ACTUAL		STANDARD
1	CURRENT RATIO	6.83	+>	2.00
2	QUICK RATIO	5.54	+>	1.50
3	INVENTORY TO WORKING CAPITAL	0.22	<	0.50
4	CASH TO CURRENT ASSETS	0.49	>	0.25
5	CASH TO TOTAL ASSETS	0.19	>	0.10
6	CURRENT ASSETS TO TOTAL ASSETS	0.40	>	0.25
7	GROSS PLANT TO TOTAL ASSETS	0.78	<	0.95
8	NET PLANT TO TOTAL ASSETS	0.60	<	0.75
9	CURRENT LIABILITIES TO TOTAL ASSETS	0.06	<	0.25
10	DEBT TO TOTAL ASSETS	0.21	*<	0.20
11	TIMES INTEREST EARNED	27.59	+>	1.50
12	CURRENT LIABILITIES TO NET WORTH	0.07	<	0.25
13	FIXED ASSETS TO NET WORTH	0.76	<	1.00
14	DEPRECIATION TO GROSS PLANT	0.08	<	0.25
15	DIVIDEND PAYOUT RATIO	0.16	>	0.10
16	CAPITAL EXPENDITURE TO GROSS PLANT	0.23	+>	0.10
17	CASH VELOCITY	4.45	>	1.00
18	INVENTORY TURNOVER	11.37	+>	2.00
19	FIXED ASSETS TURNOVER	1.44	>	1.00
20	AVERAGE COLLECTION PERIOD	54.00	<	60.00
21	TOTAL ASSETS TURNOVER	0.86	*>	1.00
22	GROSS OPERATING MARGIN	0.41	+>	0.20
23	NET OPERATING MARGIN	0.34	+>	0.15
24	SALES MARGIN	0.17	>	0.10
25	PRODUCTIVITY OF ASSETS	0.16	>	0.10
26	RETURN ON NET WORTH	0.19	>	0.10
27	OPERATING INCOME TO NET PLANT	0.49	+>	0.10
28	OPERATING EXPENSE RATIO	0.59	<	0.70

Period 2 - Cycle 2

An attempt will be made to improve upon the results of the previous simulation cycle and test the effects of the following input decisions. It will be observed that the level of sales and the corresponding levels of cost of goods sold and selling and administrative expenses are identical to those of the previous planning period. Hence, sales are projected to grow by twenty percent and this new sales level is entered as a new input decision. Corresponding levels of cost of goods sold and selling and administrative expense are entered into the system as well. It is also decided to test the effects of increasing the rate of payment of dividends on common stock by ten percent. During the previous planning period the decision was made to incur a long term debt. This decision will now be reversed and the entire long term unsubordinated debt obligation will be repaid. The sensitivity analysis indicates that none of the income statement and balance sheet variables are sensitive in relationship to the financial ratio standards. The sensitivity analysis ranks the performance of the financial ratios and emphasizes the exceptional conditions of the coverage of fixed interest charges by earnings and the specific strength of sales in relationship to the inventory level.

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DO YOU WISH TO CHANGE PRESENT PERIOD RESULTS
?YES

DO YOU WISH TO CHANGE A VARIABLE
?YES

TO IDENTIFY TYPE OF VARIABLE OR END OF CHANGE TYPE:
   NONE, EXOG, RATI, INCO, OR OTHE

VARIABLE TYPE
?INCO

VARIABLE NO.
?1

VALUE
?6414.


SALES                                5345.0000 TO     6414.0000    20%


VARIABLE TYPE
?INCO

VARIABLE NO.
?2

VALUE
?2245.


COST OF GOODS SOLD                   2060.0000 TO     2245.0000     9%
```

VARIABLE TYPE
?INCO

VARIABLE NO.
?3

VALUE
?1160.

SELLING AND ADMINISTRATIVE EXPENSE	1114.0000 TO	1160.0000	4%

VARIABLE TYPE
?INCO

VARIABLE NO.
?15

VALUE
?156.

DIVIDENDS ON COMMON STOCK	141.6000 TO	156.0000	10%

DO YOU WISH TO PRINT INPUT DECISIONS
?YES

INPUT DECISIONS FOR THE YEAR ENDING 12-31-71 (AMOUNTS X 1000000.)

SALES	6414.
COST OF GOODS SOLD	2245.
SELLING AND ADMINISTRATIVE EXPENSE	1160.
NONOPERATING EXPENSE	0.
DIVIDENDS ON PREFERRED STOCK	0.
DIVIDENDS ON COMMON STOCK	156.
PURCHASES(SALE) OF SECURITIES	0.
PURCHASE(SALE) OF FIXED ASSETS	900.
NONOPERATING INCOME OTHER THAN INTEREST	0.
SHORT TERM LOAN PAYMENT ON PRINCIPAL	0.
LONGTERM DEBT UNSUBORD. PAYM. TO PRINC.	0.
LONGTERM DEBT SUBORD. PAYM. TO PRINC.	0.
ACQUISITION(SALE) OF INTANGIBLE ASSETS	0.
NO. OF ADD. SHARES OF PREF. STOCK	0.
PRICE/SHARE OF PREFERRED STOCK	0.
NO. OF ADD. SHARES OF COMMON STOCK	0.
PRICE/SHARE OF COMMON STOCK	0.
PRODUCTION COST ON TRADE CREDIT	1200.
OTHER PRODUCTION EXPENSES	1000.

BEGINNING 12-31-69, THE VALUE OF THE NET INCOME
ON THE COMMON STOCK EQUITY COVERING A PLANNING PERIOD
OF 2 YEARS THROUGH 12-31-71 IS 2380.

THE FOLLOWING RATIOS HAVE BEEN EXCEEDED BY THE PERCENTAGES INDICATED:

NONE OF THE RATIOS HAVE BEEN EXCEEDED

THE FOLLOWING RATIOS SATISFY STANDARDS BY MORE THAN 100%:

RATIO(11)	SATISFIED BY	3883%
RATIO(18)	SATISFIED BY	1025%
RATIO(27)	SATISFIED BY	614%
RATIO(17)	SATISFIED BY	408%
RATIO(2)	SATISFIED BY	219%
RATIO(23)	SATISFIED BY	175%
RATIO(1)	SATISFIED BY	170%
RATIO(26)	SATISFIED BY	155%
RATIO(22)	SATISFIED BY	135%
RATIO(16)	SATISFIED BY	130%
RATIO(25)	SATISFIED BY	124%
RATIO(24)	SATISFIED BY	111%
RATIO(5)	SATISFIED BY	102%
RATIO(4)	SATISFIED BY	101%

DO YOU WISH TO PRINT THE WORKING CAPITAL ANALYSIS
?YES

PRO FORMA SCHEDULE OF CHANGES IN WORKING CAPITAL
FOR THE YEAR ENDING 12-31-71 (AMOUNTS X 1000000.)

CHANGES IN CURRENT ASSETS

CASH AND EQUIVALENTS	857.
ACCOUNTS RECEIVABLE	160.
INVENTORIES	-45.
TOTAL	972.

CHANGES IN CURRENT LIABILITIES

LOANS PAYABLE	0.
ACCOUNTS PAYABLE	0.
TAXES PAYABLE	312.
TOTAL	312.

WORKING CAPITAL CHANGE	660.

PRO FORMA STATEMENT OF SOURCES AND USES OF FUNDS
FOR THE YEAR ENDING 12-31-71 (AMOUNTS X 1000000.)

SOURCES

NET INCOME	1353.
DEPRECIATION	362.
AMORTIZATION	1.
LONG TERM DEBT	0.
TOTAL	1716.

USES

GROSS PLANT INCREASE	900.
GROSS INTANGIBLE ASSET INCREASE	0.
DIVIDENDS ON PREFERRED STOCK	0.
DIVIDENDS ON COMMON STOCK	156.
WORKING CAPITAL INCREASE	660.
TOTAL	1716.

DO YOU WISH TO PRINT THE INCOME STATEMENT
?YES

PRO FORMA INCOME STATEMENT
FOR THE YEAR ENDING 12-31-71 (AMOUNTS X 1000000.)

	$	CURR %	PREV %	CHG %
SALES	6414.	100	100	0
COST OF GOODS SOLD	2245.	35	35	0
SELLING AND ADMINISTRATIVE EXPENSE	1160.	18	18	0
DEPRECIATION	362.	6	6	0
AMORTIZATION	1.	0	0	0
NET OPERATING INCOME	2646.	41	41	0
NONOPERATING INCOME	0.	0	0	0
NONOPERATING EXPENSE	0.	0	0	0
INTEREST ON LOANS	44.	1	1	-31
NET INCOME BEFORE TAXES	2602.	41	40	1
FEDERAL AND STATE INCOME TAXES	1249.	19	19	1
NET INCOME	1353.	21	21	1
DIVIDENDS ON PREFERRED STOCK	0.	0	0	0
NET INCOME ON COMMON STOCK	1353.	21	21	1
DIVIDENDS ON COMMON STOCK	156.	2	2	0
NET INCOME TO RETAINED EARNINGS	1197.	19	18	1

DO YOU WISH TO PRINT THE BALANCE SHEET
?YES

PRO FORMA BALANCE SHEET AS OF 12-31-71 (AMOUNTS X 1000000.)

	$	CURR %	PREV %	CHG %	SALE %
CASH AND EQUIVALENTS	1262.	20	26	-27	20
ACCOUNTS RECEIVABLE	962.	15	14	0	15
INVENTORIES	285.	5	4	0	4
CURRENT ASSETS	2510.	40	45	-15	39
SECURITIES	14.	0	0	0	0
GROSS PLANT	4807.	77	72	0	75
DEPRECIATION	1100.	18	16	0	17
NET PLANT	3707.	59	55	0	58
GROSS INTANGIBLE ASSETS	8.	0	0	0	0
AMORTIZATION	3.	0	0	0	0
NET INTANGIBLE ASSETS	5.	0	0	0	0
TOTAL ASSETS	6236.	100	100	-6	97
LOANS PAYABLE	33.	1	0	0	1
ACCOUNTS PAYABLE	120.	2	2	0	2
TAXES PAYABLE	312.	5	5	1	5
CURRENT LIABILITIES	465.	7	7	1	7
LONG TERM DEBT UNSUBORDINATED	0.	0	7	-99	0
LONG TERM DEBT SUBORDINATED	459.	7	7	0	7
PREFERRED STOCK	0.	0	0	0	0
COMMON STOCK	272.	4	4	0	4
PAID IN SURPLUS	1039.	17	15	0	16
RETAINED EARNINGS	4001.	64	59	0	62
TOTAL LIABILITIES AND NET WORTH	6236.	100	100	-6	97

DO YOU WISH TO PRINT THE RATIO ANALYSIS
?YES

RATIO ANALYSIS FOR THE YEAR ENDING 12-31-71

		ACTUAL		STANDARD
1	CURRENT RATIO	5.39	+>	2.00
2	QUICK RATIO	4.78	+>	1.50
3	INVENTORY TO WORKING CAPITAL	0.14	<	0.50
4	CASH TO CURRENT ASSETS	0.50	+>	0.25
5	CASH TO TOTAL ASSETS	0.20	+>	0.10
6	CURRENT ASSETS TO TOTAL ASSETS	0.40	>	0.25
7	GROSS PLANT TO TOTAL ASSETS	0.77	<	0.95
8	NET PLANT TO TOTAL ASSETS	0.59	<	0.75
9	CURRENT LIABILITIES TO TOTAL ASSETS	0.07	<	0.25
10	DEBT TO TOTAL ASSETS	0.15	<	0.20
11	TIMES INTEREST EARNED	59.75	+>	1.50
12	CURRENT LIABILITIES TO NET WORTH	0.09	<	0.25
13	FIXED ASSETS TO NET WORTH	0.70	<	1.00
14	DEPRECIATION TO GROSS PLANT	0.08	<	0.25
15	DIVIDEND PAYOUT RATIO	0.12	>	0.10
16	CAPITAL EXPENDITURE TO GROSS PLANT	0.23	+>	0.10
17	CASH VELOCITY	5.08	+>	1.00
18	INVENTORY TURNOVER	22.51	+>	2.00
19	FIXED ASSETS TURNOVER	1.73	>	1.00
20	AVERAGE COLLECTION PERIOD	54.00	<	60.00
21	TOTAL ASSETS TURNOVER	1.03	>	1.00
22	GROSS OPERATING MARGIN	0.47	+>	0.20
23	NET OPERATING MARGIN	0.41	+>	0.15
24	SALES MARGIN	0.21	+>	0.10
25	PRODUCTIVITY OF ASSETS	0.22	+>	0.10
26	RETURN ON NET WORTH	0.25	+>	0.10
27	OPERATING INCOME TO NET PLANT	0.71	+>	0.10
28	OPERATING EXPENSE RATIO	0.53	<	0.70

```
 DO YOU WISH TO CHANGE PRESENT PERIOD RESULTS
 ?NO

 DO YOU WISH TO QUIT
 ?YES

STOP
```

BIBLIOGRAPHY

Albach, Horst. Investition und Liquiditaet--Die Planung des Optimalen Investitionbudgets, Wiesbaden: Gabler, 1962.

American Federation of Information Processing Societies. The State of the Information Processing Industry, New York: AFIPS, 1966.

American Management Association. Simulation and Gaming: A Symposium, Report No. 55, New York: American Management Association, Inc., 1961.

Anderson, Robert M. "Management Controls for Effective and Profitable Use of EDP Resources," Proceedings of 21st National Conference Association for Computing Machinery, Washington, D.C.: Thompson Book Company, 1966, 201-207.

Armer, Paul. Technology and the American Economy, The Report of the National Commission on Technology, Automation, and Economic Progress, Appendix, Volume I, the Outlook for Technological Change and Employment, Washington, D.C.: U.S. Government Printing Office, February, 1966, I-205-I-232.

Babb, E.M., Leslie, M.A. and Van Slyke, M.E. "The Potential of Business-gaming Methods in Research," The Journal of Business, 39:6, October, 1966.

Barnett, C.C., Jr. and Associates. The Future of the Computer Utility, New York: American Management Association, Inc., 1967.

Blumenthal, C. "Management in Real Time," Data Processing Magazine, August, 1965, 18-23.

Boessman, Eva. Die Oekonomische Analyse von Kommunikationsbeziehungen, Berlin: Springer-Verlag, 1967.

Bonini, Charles P. Simulation of Information and Decision Systems in the Firm, Englewood Cliffs: Prentice-Hall, Inc., 1963.

Boore, W.F. and Murphy, J.R. The Computer Sampler, New York: McGraw-Hill Book Company, 1968.

Brady, Rodney H. "Computers in Top-Level Decision Making," Harvard Business Review, July-August, 1967, 67-76.

Burck, G. "On-Line in 'Real-Time'." Fortune, April, 1964, 141-145.

Campise, James A. "Management by Crisis," Journal of Data Management, April, 1967, 20-24.

Canning, Richard G. "Coming Changes in System Analysis and Design," Proceedings of 21st National Conference Association for Computing Machinery, Washington, D.C.: Thompson Book Company, 1966.

Charnes, A., Cooper, W.W. and Miller, M.H. "Application of Linear Programming to Financial Budgeting and Costing of Funds," Journal of Business, February, 1959, 20-46.

Chow, Gregory C. "Technological Change and the Demand for Computers," The American Economic Review, December, 1967, 1117-1130.

Clarkson, Geoffrey P.E. Portfolio Selection: A Simulation of Trust Investment, Englewood Cliffs: Prentice-Hall, Inc., 1962.

Cleland, David I. and King, W.R. Systems Analysis and Project Management, New York: McGraw-Hill Book Company, 1968.

Clippinger, R.F. "Systems Implications of Hardware Trends," Systems and Procedures Association Journal, 18:3, May-June, 1967, 134-143.

Cohen, Jerome B. and Robbins, Rodney M. The Financial Manager, New York: Harper and Row, Publishers, 1966.

Cohen, Kalman J., Dee, William R., Kuehn, Alfred A. and Winters, Peter R. The Carnegie Tech Management Game: An Experiment in Business Education, Homewood: Richard D. Irwin, Inc., 1964.

Colbert, B.A. "Pathway to Profit: The Management Information System," Management Services, September-October, 1967, 15-24.

"Computer Usage in the Manufacturing Industry," Business Automation, October, 1966.

"Computers Spew Out Hot Advice," Business Week, May 18, 1968.

Corcoran, A. Wayne. "Matrix Bookkeeping," Journal of Accounting, 117:3, March, 1964.

Cornish, Harry L. and others. Computerized Process Control: A Management Decision, New York: Hobbs, Dorman, 1968.

Davis, Gordon B., Ambill, Howard and Whitecraft, Herbert. "Simulation of Finance Company Operations for Decision Making," Management Technology, 2:2, December, 1962.

Dean, Neal J. "The Computer Comes of Age," Harvard Business Review, January-February, 1968, 83-91.

Dearden, J. "Can Management Information Be Automated?" Harvard Business Review, March-April, 1964, 128-135.

Dearden, John. Computers in Business Management, Homewood: Dow-Jones-Irwin, Inc., 1966.

Diebold, John. "Automation: Its Impact on Business and Labor," Planning Pamphlet No. 106, Washington, D.C.: National Planning Association, May, 1959.

_____. Beyond Automation, New York: McGraw-Hill Book Company, 1964.

Dunlop, John R. (ed.). Automation and Technological Change, Englewood Cliffs: Prentice-Hall, Inc., 1962.

Dobbs, G.H. "State-of-the-Art of Data Base Systems," Proceedings of the Second Symposium on Computer Centered Data Base Systems, Santa Monica: Systems Development Corporation, 1965, 93-106.

Drattell, Alan. "Big Computers for Small Users," Business Automation, August, 1966.

Edwards, J.D. "On-Line Business Data Processing," Datamation, September, 1965, 28-31.

Elliot, Orville C. and Wasley, Robert S. Business Information Processing Systems, Homewood: Richard D. Irwin, Inc., 1965.

Emery, James C. Organizational Planning and Control Systems, New York: The Macmillan Company, 1969.

Etz, D.V. "The Marginal Utility of Information," Datamation, August, 1965, 41-44.

Finke, Walter W. "The Effect of Computers on Smaller Business," A statement before the U.S. Senate Subcommittee on Antitrust Monopoly, August 24, 1965.

Frielink, A.B. (ed.). Economics of Automatic Data Processing, Amsterdam: North-Holland Publishing Company, 1965.

Forrester, Jay W. Industrial Dynamics, New York: John Wiley and Sons, 1961.

Garrity, John T. "The Payout on Computers: What Management Has Learned About Planning and Control," Management Review, December, 1964, 4-15.

_____. "Top Management and Computer Profits," Harvard Business Review, July-August, 1963, 6-12, 172-174.

Geisler, Murray A. Development of Man-Machine Simulation Techniques, Santa Monica: Rand Corporation, March 17, 1960.

Gershefski, George W. "Corporate Models - The State of the Art," Corporate Simulation Models, Albert N. Schrieber (ed.), Providence: The Institute of Management Sciences, 1970.

Glasser, George R., Jr. "Getting Across to Management," Data Processing Magazine, April, 1966, 54-56.

Goetz, Billy E. Management Planning and Control, New York: McGraw-Hill Book Company, 1949.

Greene, F.R. and Sisson, R.L. Dynamic Management Decision Games, New York: John Wiley and Sons, Inc., 1959.

Greenberger, Martin. Computers and the World of the Future, Cambridge: The M.I.T. Press, 1962.

Greenlaw, Paul S., Herman, Lowell W. and Rawston, Richard H. Business Simulation in Industrial and University Education, Englewood Cliffs: Prentice-Hall, Inc., 1962.

Greenwood, Frank and Danziger, Erwin M. Computer Systems Analysis, New York: American Management Association, Inc., 1967.

Gregory, R.H. and Van Horn, R.L. Automatic Data Processing Systems, Belmont: Wadsworth Publishing Company, 1965.

Gruenberger, Fred and Hill, Richard H. "Let's Close the Knowledge Gap at the Top," Business Automation, May, 1966, 39-41.

Heaney, Donald S. Development of Information Systems, New York: The Ronald Press, 1968.

Henshaw, Richard C., Jr.,and Jackson, Frank R. The Executive Game, Homewood: Richard D. Irwin, Inc., 1966.

Holder, H.D. and Ehling, W.P. "Construction and Simulation of an Information-Decision Model," The Journal of Communication, 17:4, December, 1967, 302-315.

Hollander, Gerhard L. "Architecture for Large Computer Systems," Computer Design, December, 1967.

Howard, J.A. and Morganroth, W.M. "Information Processing Model of Executive Decision," Management Science, 14:7, March 1968, 416-428.

IBM Corporation. IBM Management Decision-Making Laboratory: Instructions for Participants, White Plains: IBM Corporation, 1963.

Johnson, Robert. Financial Management, Boston: Allyn and Bacon, Inc., 1959.

Kagdis, J. and Lackner, R.M. Introduction to Management Control Systems Research, TM-708/100/00, Santa Monica: System Development Corporation, 1962.

_____. "A Management Control Systems Simulation Model," Management Technology, 3:2, December, 1963.

Kahn, Arthur B. "An Appreciation of Computer Appreciation," Proceedings of 22nd National Conference Association for Computing Machinery, Washington, D.C.: Thompson Book Company, 1967, 441-445.

Kibbee, Ford M., Craft, Clifford J. and Namies, Bert. Management Games, New York: Reinhold Publishing Corporation, 1961.

Lande, H.F. Planning Systems Generator, New York: New York University, 1968.

LaMar, D.M. "Information Systems in Management Science," Management Science, 14:3, October, 1967, 114-118.

Lee, Hak Chong. "The Organizational Impact of Computers," Management Services, May-June, 1967, 39-43.

Li, David H. Accounting, Computers, Management Information Systems, New York: McGraw-Hill Cook Company, 1968.

Lipperman, L.L. Advanced Business Systems, New York: American Management Association, Inc., 1968.

Markowitz, Harry M. Portfolio Selection: Efficient Diversification of Investments, New York: John Wiley and Sons, Inc., 1959.

Martin, Francis F. Computer Modeling and Simulation, New York: John Wiley and Sons, Inc., 1968.

Mattessich, Richard. "Towards a General and Axiomatic Foundation of Accountancy--with an Introduction to the Matrix Formulation of Accounting Systems," Accounting Research, 8:4, October 1957, 328-355.

_____. "Budgeting Models and System Simulation," Accounting Review, 36:3, July, 1961, 384-397.

_____. "Budgeting in the Computer Age," Budgeting, 12:1, September, 1963, 29-32.

_____. Accounting and Analytical Methods, Homewood: Richard D. Irwin, Inc., 1964.

McLaughlin, J. Information Technology and Survival of the Firm, Homewood: Dow-Jones-Irwin, Inc., 1966.

McMillan, Claude and Gonzales, R.F. Systems Analysis, Homewood: Richard D. Irwin, Inc., 1965.

Moravec, A.F. "Basic Concepts for Designing a Fundamental Information System," Management Services, July-August, 1965.

Morstein, C.B. "Information Systems: A Basic Design Consideration," Journal of Data Management, January, 1968, 38-40.

Myers, C.A. (ed.). The Impact of Computers on Management, Cambridge: M.I.T. Press, 1967.

Newell, A., Shaw, J.C. and Simon, H.A. "Report on a General Problem-Solving Program," Proceedings of the International Conference on Information Processing, Paris: UNESCO, 1959, 256-264.

_____. "A Variety of Intelligent Learning in a General Problem Solver," Self-Organizing Systems, M. Younts and S. Cameron (eds.), New York: Pergamon Press, 1960.

Optner, S.L. Systems Analysis for Business Management, Englewood Cliffs: Prentice-Hall, Inc., 1960.

Parkhill, D.F. The Challenge of the Computer Utility, Reading: Addison-Wesley Publishing Co., 1966.

Prince, Thomas R. Information Systems for Management Planning and Control, Homewood: Richard D. Irwin, Inc., 1966.

Raymond, R.C. "Use of the Time-Sharing Computer in Business Planning and Budgeting," Management Science, 12:8, April, 1966, B363-B381.

Ream, N.J. "On Line Management Information," Datamation, March, 1964, 27-30.

Ricciardi, Frank M. et al. Top Management Simulation: the AMA Approach, Elizabeth Marting (ed.), New York: American Management Association, Inc., 1957.

Sanders, Donald H. Computers in Business, New York: McGraw-Hill Book Company, 1968.

Sass, Margo A. and Wilkinson, William D. Computer Augmentation of Human Reasoning, Washington, D.C.: Sparton Books, Inc., 1965.

Schreiber, Albert N. "Gaining a New Way to Teach Business Decision Making," University of Washington Review, 17:7, April, 1958.

Schoderbek, Peter P. (ed.). Management Systems, New York: John Wiley and Sons, Inc., 1967.

Schwab, Bernhard. "The Economics of Sharing Computers," Harvard Business Review, September-October, 1968.

Simon, Herbert A. The New Science of Management Decision, New York: Harper and Brothers, 1960.

_____. "The Corporation: Will it be Managed by Machines?" Automation: Implications for the Future, Morris Philipson (ed.), New York: Random House, Inc., 1962.

Simon, Herbert A. and Newell, A. The Simulation of Human Thought, Santa Monica: Rand Corporation, June, 1959.

_____. "Heuristic Problem Solving: The Next Advance in Operations Research," Operations Research, 6:1, January-February, 1958.

_____. "Simulation of Human Thinking," Management and the Computer of the Future, Martin Greenberger (ed.), New York: John Wiley and Sons, Inc., 1962.

Smith, R.D. and Greenlaw, P.S. "Simulation of a Psychological Decision Process in Personnel Selection," Management Science, 13:8, April, 1967, B409-B419.

Smith, W. Nue, Estey, Elmer E. and Vines, Ellsworth F. Integrated Simulation, Cincinnati: South-Western Publishing Company, 1968.

Sprowls, R.C. and Asimow, M. "A Computer Simulated Business Firm," Management Control Systems, D.G. Malcolm, A.J. Rowe and L.F. McConnell (eds.), New York: John Wiley and Sons, Inc., 1960, 321-332.

Stedry, Andrew C. Budget Control and Cost Behavior, Englewood Cliffs: Prentice-Hall, Inc., 1960.

Stokes, Paul M. A Total Systems Approach to Management Control, New York: American Management Association, Inc., 1968.

Taylor, W. Bayard. Financial Policies of Business Enterprise, New York: D. Appleton-Century Company, Inc., 1942.

Teichroew, Daniel and Lubin, John Francis. "Computer Simulation - Discussion of the Technique and Comparison of the Languages," Communications of the ACM, 9:10, October, 1966.

West, Jerome D. "Heuristic Programs for Decision Making," Harvard Business Review, September-October, 1966, 129-143.

Weston, J. Fred and Brigham, Eugene F. Managerial Finance, New York: Holt, Rinehart and Winston, 1966.

Withington, Frederic G. The Use of Computers in Business Organizations, Reading: Addison-Wesley Publishing Company, 1966.

Ziegler, James R. Time-Sharing Data Processing Systems, Englewood Cliffs: Prentice-Hall, Inc., 1967.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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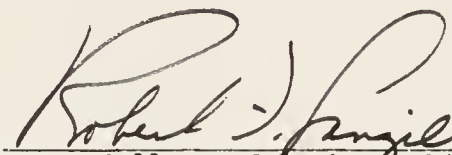

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